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SCIENCE

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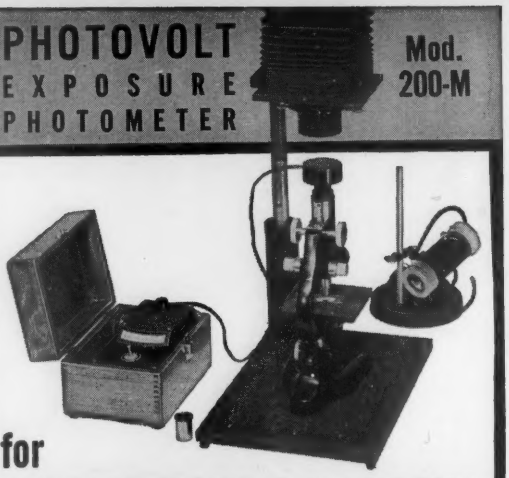

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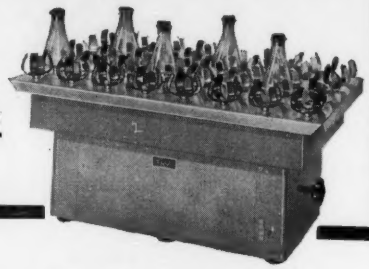

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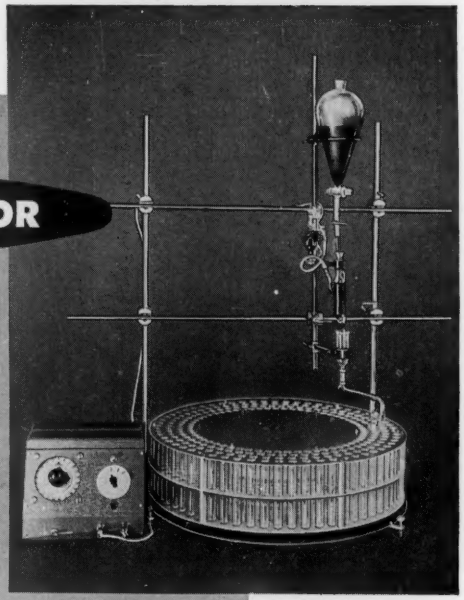

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Translations from the Russian

In this space we recently described the highly centralized abstracting and translation arrangements in the Soviet Union [*Science* **124**, 609 (5 Oct. 1956)]. The United Kingdom and the United States have a corresponding need for scientific information from the Soviet Union, a need now being met in a different, but perhaps no less effective, way.

The Department of Scientific and Industrial Research in the United Kingdom exchanges information about translations and abstracting with the several agencies of the U.S. Government that are concerned. In the United States the general pattern of operation is for government agencies to furnish financial support to private organizations, which in turn arrange for abstracting and translating foreign material. The American Institute of Physics, with the support of the National Science Foundation, translates four Soviet journals, which run to about 10,000 pages a year. In cooperation with the National Institutes of Health, NSF plans to arrange for the translation of several Soviet journals in biology by private organizations. In a similar way, NSF supports the American Mathematical Society, which thoroughly screens Soviet literature and selects papers of the greatest interest for translation. Similar arrangements will soon be worked out for geophysical information.

The U.S. Atomic Energy Commission meets its specialized needs for translation by contract with Consultants Bureau, Inc., of New York, and the National Institutes of Health are planning an extensive program of translation of Soviet journals, abstracts, and monographs in biology and medicine, partly by contract with the Consultants Bureau and partly by funds assigned to NSF and possibly other appropriate groups.

This is necessarily an incomplete picture of what is going on. Some commercial translators, including the Consultants Bureau, have been translating selected Soviet literature for some years and have made a considerable contribution. Another institute for translating is in the process of formation. I. R. Maxwell, managing director of Pergamon Press, has founded a nonprofit corporation, the Pergamon Institute of Russian Science, Technology, and Medicine, to prepare abstracts, translations, reviews, and dictionaries. The project is conceived on a large scale and will supplement, rather than compete with, other translation programs. The institute will be incorporated in both the United Kingdom and the United States. Its organization on a nonprofit basis makes it possible, and indeed probable, that it will attract support from foundations and governments on both sides of the Atlantic.

These undertakings, at first sight so diverse and uncentralized, promise to make the results of Soviet science available with dispatch and efficiency and, what is equally remarkable, without duplication of effort. The mode of operation is a good illustration of the curious Anglo-American capacity to blend governmental and private interests effectively and to keep bureaucratic control at a minimum.—G. DUS.

It is with deep regret that we announce the death of Mark H. Adams, a member of the Editorial Board of *Science* and *The Scientific Monthly*. His uncompromising integrity, high standards, penetrating judgment, and sharp discrimination led us to depend on him for advice about many difficult editorial decisions. His death is a serious loss to science and a deep personal loss to us.—EDITORIAL BOARD.

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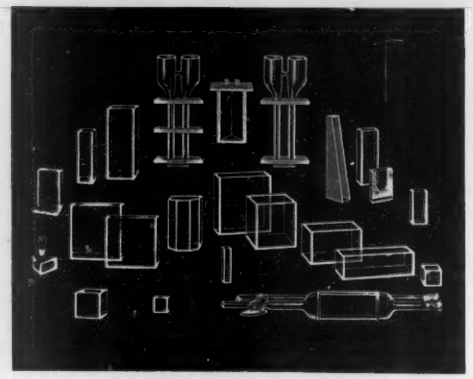

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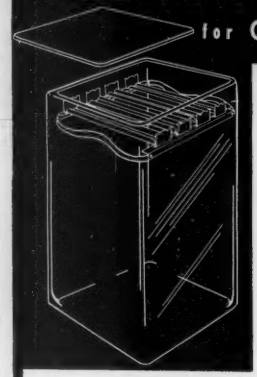

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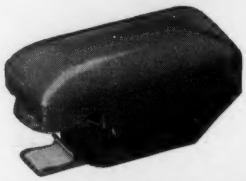

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Bioenergetics

Albert Szent-Györgyi

The most basic property of the heart is that it is a muscle, and the chief property of muscle is that we do not understand it. The more we know about it, the less we understand and it looks as if we would soon know everything and understand nothing. The situation is similar in most other biological processes and pathological conditions, such as the degenerative diseases. This suggests that some very basic information is missing. The story of myosin may illustrate this point.

Energetics of Myosin

Myosin is the main contractile protein of muscle. It converts the chemical energy of adenosine triphosphate (ATP) into motion. From the work of Edsall, Weber, and their associates, we knew that the myosin molecule was a rodlet (*1*), as is indicated in Fig. 1*a*. We had little doubt that contraction, essentially, was a folding, as is symbolized in Fig. 1*b*. We supposed that the ATP produced this folding by attaching itself at a point to myosin and producing there a change which, sooner or later, could be described in terms of classical chemistry.

The first disturbance in this happy state of affairs was caused by the studies of Gergely, Perry, and Mihalyi, who found that myosin has a complex structure and is built of two kinds of subunits (*2*), which were isolated subsequently by Andrew G. Szent-Györgyi and called *meromyosins*. The one sedimenting faster was called H (heavy) and the other L (light). There were twice as many L's as H's, and they were arranged in series, in a row, as is symbolized in Fig. 1*c*. What was disturbing about this finding was the fact that the L seemed to be involved in contraction, while the H alone interacted with ATP. How could the energy released on the H support work done by the L's? How could a bond-energy locked up in a chemical link produce work somewhere else? It was still possible to make theories to save the situation and suppose, for instance, that ATP produced some local change on the H, whereupon the L folded back on the H, but these theories began to look rather artificial.

The real difficulty arose when A. G. Szent-Györgyi and Borbiro (*3*) made the discovery that the meromyosins themselves are built of a great number of much smaller subunits, *protomyosins*, which are held together only by secondary links, such as H-bonds, van der Waals forces, and electric attractions. The myosin "molecule" was thus no molecule at all, if we call a molecule a structure of atoms held together by covalent links. The myosin particle was but a regular heap of still smaller particles, as is symbolized in Fig. 1*d*.

Contraction and Electronic Excitation

Secondary links have no fixed valency angles, which must give a great pliability to the structure. It became difficult to see how such a structure could "fold." It seemed more probable that contraction consisted of a rearrangement of protomyosins, which went into a more compact heap, as is symbolized in Fig. 1*e*. There must be strong attractive force between protomyosins to enable the myosin particle to withstand strain, and these forces must tend to pull the protomyosins closer together. The force of muscular contraction could thus be due to these attractive forces, in which case we would need force to stretch the particle out again. This theory of contraction is simple and attractive. The difficulty is with ATP, which induces contraction and foots the energy bill. In order to induce a rearrangement of protomyosins, an ATP molecule would have to influence many weak links, but how could a "bond energy," locked up in a molecule, influence many links, especially if that molecule is far away? To bridge this gap, we would have to suppose that the bond energy of the ATP molecules is transformed into some more mobile and active form of energy when it has to go into biological action. Such an energy, on the molecular level, could hardly be anything other than the energy of electronic excitation. Vibrational energies would, probably, be dissipated too easily. Practically all molecules are excitable by light of one wavelength or another, but most of them immediately dissipate their excitation energy and would thus be unfit to partake in biological energy transmissions. Only a relatively small number of specifically built molecules do not dissipate their excitation energy immediately. But, as a rule, no electron can stay in the excited state longer than 10^{-8} second, and, if the molecule is unable to dissipate its excess energy, the electron will drop back to its ground level in 10^{-8} second, shooting out its excess energy in the form of a photon. This means that the molecule is fluorescent. Fluorescence thus becomes an indicator of qualities that may have a major biological importance, indicating that the molecule can accept energy without dissipating it.

It could be objected that such excitation energies can play no role in biological energy transmissions because 10^{-8} second is too short a time to allow their utilization. However, there is always a small but definite chance that the excited electron may revert its spin, which would greatly prolong its lifetime. With its spin reverted, the electron is in the "triplet state," from which it cannot drop back to its original energy level, because the single energy levels of an atom can be occupied by no more than 2 electrons, and only by 2 electrons of opposite spin. The reverted spin of the excited electron having become parallel to that of its earlier partner, its return to its ground level is "forbidden" by quantum rules. So the electron has to remain in its excited triplet state till a thermic collision dissipates its energy.

The physicist who wants to study triplet states has to protect his excited elec-

Dr. Szent-Györgyi is a member of the staff of the Institute for Muscle Research at the Marine Biological Laboratory, Woods Hole, Massachusetts. This article is based on a lecture given at the heart symposium of the 20th international Physiological Congress in Brussels on 31 July 1956. The underlying studies will be published in their entirety by Academic Press in a monograph of the same title.

trons from thermic agitation. This he can do, to some extent, by enclosing the excited molecules in a rigid medium—for instance, by dissolving his substances in melted borax, which he then allows to solidify. He can also use liquid solvents, like glycerol, which he subsequently freezes to a "glass" in Dry Ice, or liquid nitrogen. The more electrons there are in the triplet state, the greater the chances that some of them will drop back to the ground level, sending a message to the observer in the form of an emitted photon. Such light emission from the triplet state is called, after the pioneering studies of G. N. Lewis and his associates (*4*), *phosphorescence* to distinguish it from *fluorescence*. It can be identified as phosphorescence by measuring the time that elapses between excitation and light emission. This can be done in a phosphoroscope, and if the lifetime is found to be of the order of 10^{-3} second or more (instead of 10^{-8} or 10^{-9}), then it is phosphorescence.

Excitations and Water

But here again the physicist may object to biological implications, because a transition into the triplet state has a very small probability of occurring, and a transition that is improbable can have no major biological meaning. I wasted 4 years in futile attempts to break through these difficulties. Lately it occurred to me that the physicists, in their studies on this line, never used water as solvent. They had a good reason to avoid it, for ice at low temperatures cracks up and becomes optically inhomogeneous, making exact measurements impossible. But the biologist is inseparably linked to water, which is the matrix of life, and water has many exceptional properties that may have played a hand also in the generation of life and might also alter the probability of electronic transitions. The most notable quality of water is its strong dipole character with its resulting high dielectric constant. I thus reinvestigated the problem, dissolving fluorescent substances in water, freezing my solutions in Dry Ice, and looking at them under an ultraviolet lamp mounted with a filter that passed only ultraviolet light that could excite the fluorescent matter without interfering with visual observation. All substances behaved in an extraordinary fashion, going, if excited, into the triplet state, opening up a new and colorful world. This may be illustrated by two examples.

If a glycerol solution of the dye rhodamine B is frozen, freezing makes no difference in the behavior. Frozen or unfrozen, the solution shows the same brilliant orange fluorescence. The situation is similar if the solvent is water with 10-percent glycerol. However, if pure water is used as solvent, then, on freezing, all fluorescence disappears. That this disappearance of the light emission is the result of the electrons' going into the triplet state can be shown by cooling the solution to lower temperatures. Below $-40°C$, the system begins to emit a red light, and the lifetime of the underlying excitation exceeds 10^{-3} second. If 3-percent glucose is present, the light emission is very intense, and the lifetime is around 1 second. Hence, if the illumination is suddenly disconnected, the solution shows a strong afterglow.

Riboflavin phosphate, one of the most important pieces of the oxidative machinery of the cell, is known for its brilliant yellow-green fluorescence, which it displays under the ultraviolet lamp if it is present in a watery solution or if it is frozen in 10-percent glycerol. If the molecular oxygen present is eliminated and a watery solution of riboflavin is frozen, its fluorescence disappears. If a trace of oxygen is admitted, the system assumes a red-brown phosphorescence (*5, 6*). Because there are many more riboflavin than oxygen molecules present, this change cannot be due to a direct interaction between riboflavin and oxygen. What happened, probably, was the following: on freezing, the excited riboflavin molecules went into the triplet state, from which they could emit no light, the transition from the triplet to the ground state being forbidden. This situation was altered by the oxygen, which, as a paramagnetic molecule, perturbed the electromagnetic field; in this perturbed field the transition to the ground state became possible, and thus electrons emitted their excess energy in the form of the red-brown phosphorescence. Oxygen thus profoundly alters the reactivity of riboflavin and it is possible that riboflavin fulfills its role in such an altered state *in vivo*, oxygen not merely being an electron acceptor but also acting by tuning the reactivity of the molecules that cater to the electrons it finally accepts. This may have far-reaching biological implications, and it may also explain the mysterious interrelations between oxidation and fermentation (Pasteur reaction).

This simple experiment not only shows that water can stabilize triplet states but also shows that the further reactions of the triplets are accessible to regulatory influences. This can also be shown by freezing a riboflavin solution in the presence of air and $10^{-3}M$ potassium iodide. Potassium iodide completely abolishes the phosphorescence. This may evoke biological associations, for iodine, in the form of thyroxin, is one of the main regulators of the energy household, and Kasha (*7*) has shown that its influence on triplet transitions is independent of its state, being due to its high atomic number—that is, to its heavy nucleus. The great number of its electrons may enable it also to take over energies from other excited molecules. In any case, in our frozen medium collisions of molecules are very limited, and so we can suppose that iodine did not exert its action by a direct collision but *par distance*, being coupled to the excited molecules by the interlying electromagnetic field.

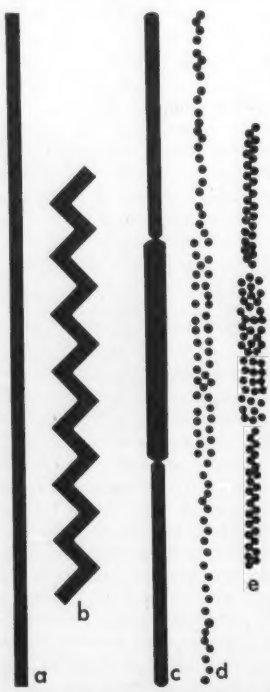

Fig. 1. The myosin molecule.

Structured Water

The main question is: Why does freezing introduce such a change? The answer is evident: Ice is not just solid water. It is a crystalline solid with a regular structure. Modern physics places less emphasis on the idea of "liquid" and "solid" than on "random" and "regular." Glass has no crystalline regularity, and thus to the physicist it is a liquid of high viscosity, like frozen glycerol.

The biologist may feel inclined to reject the biological implications of all this, there being no "ice" in the body. But probably there is. It seems even likely that our cells contain but very little or no random water at all, but do contain ice, or, more exactly, water which acquires an ordered structure around surfaces or molecules. Observations on this line were published, for example, by Palmer, Cunliffe, and Hough (*8*), who found that around mica plates water behaved

as "liquid ice" and showed dielectric properties that pointed to an ordered state. Dramatic developments were precipitated by the observation that gas pipes carrying natural gas may freeze up even in the summer. The studies of Buswell and Rodenbush, summed up lately in a fascinating article (*9*), showed that water forms cubic lattices around nonpolar substances. In Sweden, B. Jacobson (*10*) showed that electropolar groups on surfaces may also induce order in the adjacent water. Hence, there is every reason to believe that most of the water in the closely packed protoplasm of cells is in an ordered state that may render triplet excitation probable and stable.

The introduction of the electromagnetic field and water structures into biology as a matrix could not fail to have far-reaching consequences, and so we may do well to look around for evidence. Naturally, such a theory cannot be proved by any single observation and can gain weight but gradually by suggesting useful experiments or making biological reactions appear in a new light, offering an explanation for unexplained phenomena.

Unsolved Problems

Where competitive inhibition or complex formation are excluded, the molecular mechanism of drug actions is obscure. Hormones and drugs produce violent reactions in the body even though they are chemically inert, and the problem is how can a molecule that does nothing chemically produce a reaction? Hence, the question arises whether they do not act by influencing electronic excitations in one way or another. This assumption could be supported by showing that drugs are capable of influencing electronic excitation *in vitro* in the same concentration in which they produce reactions *in vivo*. Very specific drugs may be accumulated by their target, and so we do not know in what concentration they actually act, but in the case of less specific drugs we can calculate with a random distribution and thus compare biological action and *in vitro* activity. For example, 2,4-dinitrophenol produces marked changes in metabolism in man in doses of 100 milligrams. This corresponds to a random concentration of the order of $10^{-5}M$. If this action is due to an action of the excitation of riboflavin, then $10^{-5}M$ dinitrophenol should affect these excitations also *in vitro*. This is actually the case, and it is easy to show that 2,4-dinitrophenol actually quenches the phosphorescence of riboflavin in this concentration. Two more drugs have been analyzed in an analogous fashion with similar results—2,4-dichlorophenoxyacetic acid and chloropromazine. The first is known to produce myotonia in mice in doses of 200 milligrams per kilogram. In this concentration it greatly shortens the lifetimes of various triplet excitations. Chloropromazine has other, very colorful actions on electronic transitions in concentrations in which it affects the basal metabolic rate and induces hypothermia in experimental animals. So have serotonin and lysergic acid, while alcohol upsets triplet excitations in concentrations in which it makes us tipsy.

We can extend such preliminary experiments in various directions. A simple experiment is the following: acridine orange is frozen in water, whereupon it shows a weak red-brown phosphorescence coming from a relatively short-lived excitation. If a small quantity of cortisone is dissolved in the water, the lifetime becomes very long, of the order of seconds. A trace of a narcotic, such as chloroform or ether, cuts down the lifetime again to its original value, inviting speculation about the nature of narcosis. Similarly, the lifetime of the excitation of rhodamine in frozen water is relatively short, of the dimension of 10^{-3} second. Addition of glutathione in physiological concentrations prolongs it 1000-fold, which may give a clue to the role of sulfur in biological systems. One of the oldest mysteries of biology is why, in our bodies, potassium is kept inside our cells and sodium outside of them. The dimensions of the potassium ion are such that it just fits nicely into the water lattice, while sodium (which has a bigger hydrate shell) does not do so and has to cause a disturbance. So, if the regularity of water structures is important for life, then the presence of sodium in greater quantity would be incompatible with it. A watery rhodamine solution, if frozen in Dry Ice in the presence of $0.1M$ KCl, shows practically no light emission under the ultraviolet lamp, while, if it is frozen with $0.1M$ NaCl, it shows a splendid red glow, which indicates disturbed water structures. It is very impressive to see the difference of the two ions demonstrated visually in such a simple and striking manner. Muscle, if stained with acridin orange, shows at room temperature a red phosphorescence showing that within the tissue the dye behaves in the same way as it does in ice. (The dye seeping out of the tissue into the underlying filter paper shows the usual green fluorescence.) These examples may suffice to indicate that it seems likely that triplet excitations play a major role in biology and invite extensive experimentation.

To return to muscle, my point of departure, a theory of its contraction suggests itself. It may be that muscular contraction, essentially, is a rearrangement of protomyosins, consecutive to a destruction of their surrounding water structures, while relaxation is the reestablishment of this hydrate envelope. It is possible that the destruction is done by the energy of ATP, released in the form of a triplet excitation which interacts with the water structures (*11*).

Conclusion

All this suggests that biological phenomena, such as muscular contraction, cannot be described in terms of classical chemistry but belong to the domain of quantum mechanics, to "quantum biology."

The experiments described here indicate that we will have to introduce three new factors into our thinking if we want to understand biological reactions: water structures, the electromagnetic field, and triplets or some other unusual form of excitation made possible by water structures. As Chargaff says in a recent article (*12*), we have forgotten how to say "don't know." The three factors mentioned may limit the number of questions to which we have to give this answer.

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Neolithic Period in Switzerland and Denmark

J. Troels-Smith

The first problem taken up by the Radiocarbon Dating Laboratory in Denmark dealt with the Alleröd climatic oscillation (*1*). The second has been the dating of the oldest Neolithic period in Europe.

Two dwelling places were chosen as especially well suited: Egolzwil 3, Wauwilermoos, Lucerne, Switzerland, and Mul. I, Aamosen, Zealand, Denmark. In both places, the culture layers are imbedded in Quaternary sediments, which makes palynologic pollen analytic dating of the layers possible. It is a further advantage that not only charcoal but also other organic material such as wood, bark, hazelnut shells, gyttja, swamp peat, and so forth, are preserved and can be used for radiocarbon dating.

H. Tauber has given the age determinations on these samples (*2*). Some comments are presented in the following paragraphs, on archeologic, geologic, and botanical aspects in connection with a discussion of both dwelling places (*3*).

Switzerland

The dwelling place Egolzwil 3 is situated about 30 kilometers northwest of Lucerne, Switzerland, in the northern part of the former Lake Wauwilersee, which is now dried out. The archeological investigation of the culture layers was performed by Emil Vogt of the Landesmuseum in Zurich (*4, 5*). The artifacts found in the culture layer originate in the Older Cortaillod culture which, culturally, belongs to the Western European neolithic culture group. The Cortaillod culture represents the oldest agriculture that has been found to date in Middle Switzerland. In the culture layer was found a beautifully ornamented earthen vessel of Rössen type, which indicates that the Older Cortaillod culture must be contemporary with the Rössen culture.

The culture layer is imbedded in a layer of calcareous lake mud. Toward the land, the latter is approximately 0.60 meter thick, and toward the former lake it is 2 meters thick above the culture layer. Underneath the culture layer, the calcareous mud extends to a depth of at least 1 meter. Geologic investigations and pollen analyses, carried out in connection with the archeological excavation, indicate that, at the time of the settlement, there was a more or less dry pasture; this is in agreement with Vogt's viewpoint, which is based on archeological studies (*4–6*).

Through pollen analyses, the dwelling place can be dated to the time immediately after the first strong decline of the beech curve. It should be noted, however, that the fall of the beech curve is most probably the result of the fact that the first peasants on the place cleared the beech forest in order to gain space for arable land and to promote growth of trees that provided useful leaf fodder. This means that the fall of the beech curve is not due to climate and, consequently, it cannot directly be applied as a synchronous level. On the other hand, it is reasonable to assume that the oldest neolithic agriculture in Switzerland was so extensive that the beech fall occurred almost simultaneously at locations within the Swiss lowland between the mountains of Jura and the Alps. Furthermore, it should be mentioned that the lake marl at the bottom of the culture layer and 0.10 meter down contains pollen of plants favored by culture—that is, broad-leaved plantain and cereal—so that we have reason to assume that the culture layer does not represent the very oldest agriculture in this region, although the difference in time can only be insignificant (Fig. 1) (*6*).

While the material for the carbon-14 measurements was being collected, the following viewpoints were considered important. (i) The samples must with certainty be synchronous with the culture layer. (ii) It is desirable, whenever possible, to obtain samples of different organic material.

Samples of vertical piles were therefore deliberately rejected as dating material, since it is difficult to ascertain their simultaneity with a given culture layer. Samples K-115 and K-116 were taken from wood that was imbedded horizontally in the culture layer proper; their dates are 2550 ± 150 B.C. and 3130 ± 280 B.C., respectively. Sample K-118 consisted of lime bark that was found directly below the culture layer. Vogt assumes that the dwellers used bark to protect themselves from the moisture of the ground. The result of three determinations gives a date of 2830 ± 140 B.C. Further, charcoal (sample K-121) was dated to 2770 ± 130 B.C. Consequently, the mean date of the culture layer is found to be 2740 ± 90 B.C. (7–9).

From a geologic point of view, it will be difficult at the present to gain more than a rough estimate of the age of the dwelling place; from an archeological viewpoint, one might set the date closer to 2000 B.C. than to 3000 B.C. because the Older Cortaillod culture is contemporaneous with the Rössen culture, which, in turn, must be younger than the Older and the Younger Danubian culture. On the other hand, if the carbon-14 determinations performed on material from Older Danubian culture dwellings (charred wheat, Westeregeln, Magdeburg, 4250 ± 200 B.C.; and charcoal, Wittislingen a.d. Donau, Dillingen, 4080 ± 110 B.C.) (*10*) are correct, this culture is so much older than has hitherto been assumed that the dating result of 2700 B.C. for both the Cortaillod culture and the Rössen culture appears to be reasonable.

While the Cortaillod culture apparently advanced from the west or southwest into Switzerland, the Michelsberg culture belongs to the northern and eastern parts of Switzerland. The finds that indicate a certain contact between these two cultures should be dated to the Younger Cortaillod culture. Recently, wood from the Michelsberg dwelling place, Weiher, near Thayngen in northeastern Switzerland, has been dated in Groningen; the result is 2780 ± 130 B.C. (*10*). This result means that the wood is contemporary with the Older Cortaillod culture of Egolzwil 3. Consequently, the Michelsberg culture becomes older than has been assumed so far. Near Weiher, three cultural horizons have been observed, and it would be important to know from which of these horizons the dated wood originated.

Denmark

The dwelling place Mul. I (Sandlyng complex, Aamosen, Zealand, Denmark) has been excavated in the course of the last 5 years under my direction. The artifacts that have been found belong to the late Ertebølle culture and are characterized by typical flat-trimmed flake axes, blade implements, and transverse arrow heads; numerous small bore points are typical of the dwelling place, together with oblong flake scrapers and

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round discoid scrapers, and a flake of a polished, pointed-botted, flint axe. Also ceramics, both thick-walled and coarsely built of strips, and thin-walled and of laminated structure, were found. The first shards correspond to the typical, pointed base Ertebølle vessels, while the latter, with respect to both material and to ornamentation, point to the A-ceramic that was suggested by Becker (*11*). The bones found originate from game: red deer, roedeer, boar, beaver, and so forth. However, a few finds indicate knowledge of agriculture—for example, an impression of a wheat grain in a shard belonging to an A-vessel, and some bones of tamed cow, sheep, or goat.

The excavation was carried through by means of a minute technique which, together with stratigraphic investigations, shows that all artifacts must have been left behind on the place within a very short period of time (*12*). The culture layer is covered by alder-wood peat to a thickness of 1 meter and rests on a layer of swamp peat 0.40 meter thick. The layer of swamp peat is separated from the underlying calcareous lake mud by a layer of drift mud varying in thickness from 0.10 to 0.30 meter. In the drift mud, artifacts occur which are identical with those imbedded in the culture layer that is situated about 0.40 meter higher. It can, for example, be mentioned that potsherds found in the drift mud fit together with potsherds from the culture layer.

Although it is most reasonable to assume that the drift mud was deposited simultaneously with the layer of the dwelling place, the theoretical possibility cannot be excluded that the drift mud and the artifacts found in it could have been deposited at a later period. The palynologic dating of the place shows that the drift mud was deposited at a time after the decline of the *Ulmus* curve and before lanceolate plantain started to spread in larger quantities in this region. The dating of the dwelling-place layer—which presupposes that the deposition of the culture layer and the drift mud occurred at the same time—is in agreement with the fact that four palynologic datings of singly found earthen vessels of Becker's type A should belong to exactly the same period in the pollen diagrams. This finding indicates that the drift mud was deposited simultaneously with, or at least but slightly later than, the culture layer (Fig. 2).

The material used for the carbon-14 dating of the dwelling place originated partly from the culture layer proper—for example, bark (samples K-124, K-125, and K-126), hazelnuts (samples K-128 and K-129), and charcoal (samples K-131 and K-132). Other material consisted of alder-wood peat from directly above the culture layer (sample K-127), swamp peat from immediately below the culture layer (sample K-123), swamp peat mixed with mud from directly above the drift mud (sample K-148), and calcareous lake mud from directly below the drift mud (sample K-149). From the drift mud proper, four samples have been dated, two single samples from the center of the layer (K-122 and K-156) and two samples from the same place as K-148 and K-149—that is, sample K-137, which was taken in the upper part of the drift mud, and sample K-136, which was

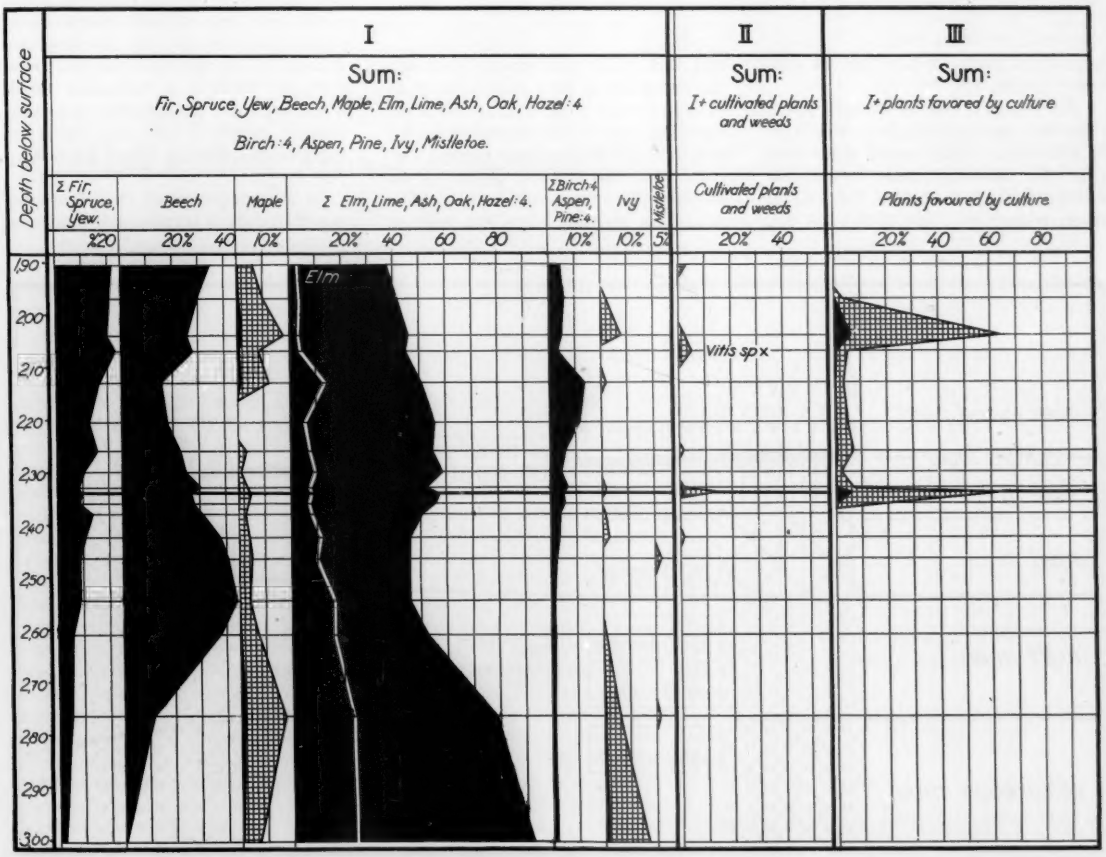

Fig. 1. Pollen diagram of locality about 5 meters south of the dwelliing place Egolzwil 3 toward the former lake. The black silhouettes give the percentages, and the shaded curves give percentage × 10. The heavy line between 2.30 and 2.40 meters below the surface indicates the location of the dwelling place in the diagram (*13*).

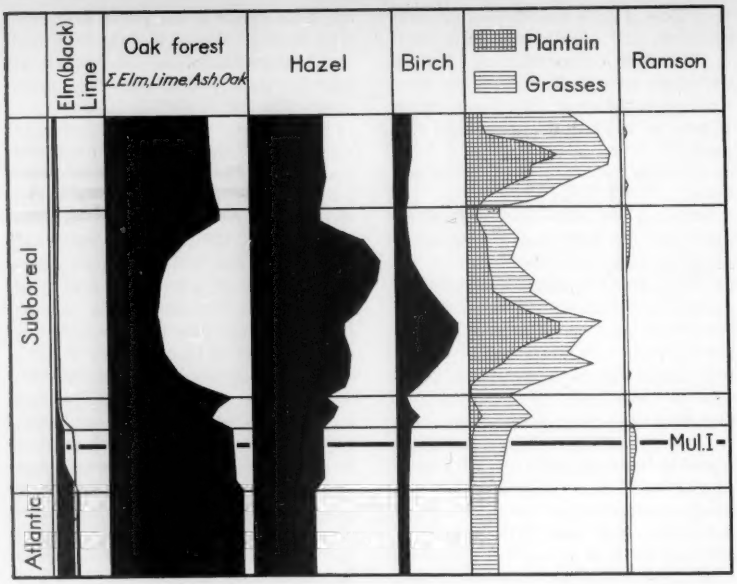

Fig. 2. Schematic pollen diagram showing the occurrence of some important trees and herbs in late Atlantic and early Subboreal time. The full-drawn curves indicate percentages, the shaded ones give percentage × 10. The heavy line indicates the pollen-diagrammatic age of the dwelling place Mul. I (*14*).

taken from the lower part (see the schematic profile, Fig. 3).

The carbon-14 date of the bark, hazelnuts, and charcoal from the culture layer is 2630 ± 80 B.C. The dates of alder-wood peat from above the culture layer and of swamp peat from below the culture layer, respectively, are 2700 ± 120 B.C. and 2530 ± 120 B.C. Strangely enough, the younger peat layer turned out to be older, and vice versa. This is within the statistical error of the measurements, but still, the carbon-14 dating seems to indicate that the building period of the dwelling place was very short; in other words, the dwelling place was built on the swamp peat that was deposited during the immediately preceding period, and the culture layer was covered by alder-wood peat immediately after the settlement was abandoned. The mean of the two figures gives an age very close to that of the artifacts.

The dating results of the samples of drift mud call for more detailed comments. Samples K-137, K-136, and K-156 are obviously older than the culture layer—that is, they date 3200 ± 160 B.C., 2970 ± 180 B.C., and 2850 ± 160 B.C., respectively, while the fourth sample (K-122) is clearly younger than the culture layer. To clarify this finding, another sample (K-148) consisting of swamp peat mixed with noncalcareous mud was taken from the lower edge of the former floating island of swamp peat; its date was determined to be 3530 ± 170 B.C.; thus it is markedly older than the underlying drift mud. Furthermore, a sample (K-149) was taken from directly under the drift mud where samples K-137 and K-136 were taken; it was composed of calcareous lake mud. The organic fraction of the sample was dated to 3660 ± 180 B.C. It is possible that this sample contained aquatic plants which can have utilized prequaternary carbon and, consequently, the date may turn out to be somewhat too old. However, the result is in reasonable agreement with the geologically somewhat younger sample K-148 from the lower edge of the floating island of swamp peat.

As a consequence of the afore-mentioned datings, it is reasonable to assume

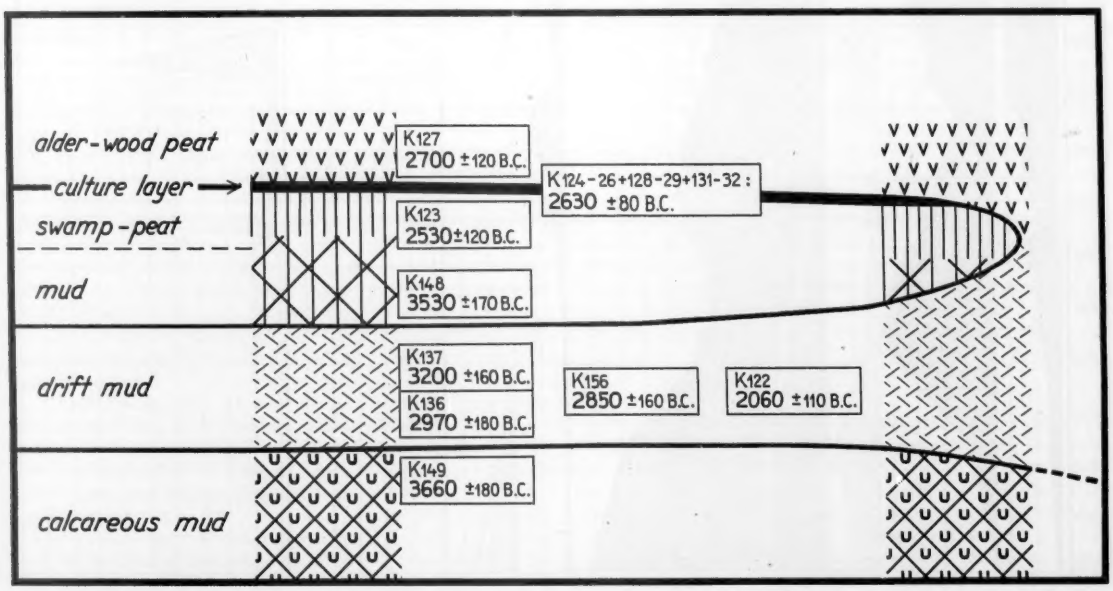

Fig. 3. Schematic section through the dwelling place Mul. I. The dwelling place rests on humified swamp peat and is covered by alder-wood peat. Under the floating island of swamp peat and mud, in the drift mud, artifacts similar to those in the culture layer have been found.

that the drift mud that was interposed between these two layers at a later period has taken up material from the surrounding older layers. This explanation also applies to the sample of drift mud, K-156. With regard to the drift-mud sample K-122, this dating result is difficult to understand. If one does not anticipate contamination of this sample, the possibility exists of a renewed elevation of the island of swamp peat at a later time than the elevation which caused the deposit of drift mud of samples K-137, K-136, and K-156. There is at present no stratigraphic or geologic evidence that this happened. However, the investigations are not yet concluded, and the comments offered here are an attempt at a preliminary interpretation of the results obtained to date.

Conclusion

The main result of the age determinations is that the oldest agricultures in Switzerland (Older Cortaillod culture) and in Denmark (Younger Ertebølle culture and A-earthen vessel) started almost simultaneously, about 2740 ± 90 B.C. and 2620 ± 80 B.C., respectively. Furthermore, the first marked fall of the beech curve in Switzerland is essentially synchronous with the decline of the elm curve in the Danish diagrams.

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3. I wish to express my gratitude to the Carlsberg Foundation for a travel grant that enabled S. Jørgensen and me to go to Switzerland in 1952. The permission of the Heimatsvereinigung Wiggertal and of Emil Vogt, Landesmuseum, Zurich, to take samples for radiocarbon dating from the dwelling place Egolzwil 3 is highly appreciated.
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8. Recently, Zeuner (*9*) published two datings from Egolzwil 3. The material was collected by W. Lüdi, Forschungsinstitut Rübel, Zurich, during the excavation in 1952. The expected date of the culture layer, according to Lüdi, is about 1900 B.C. ("The expected age is based on pollen analytical correlation, the absolute age being ultimately dependent on the Swedish varve scale.") The result of the dating is "G1.17, oak, 4000 ± 110 : c. 2050 B.C.; G1.18, ash, 4650 ± 110 : c. 2700 B.C." It would be of interest to know whether the material was taken from vertical piles or from piles imbedded horizontally in the culture layer. In the latter case, the settlement in this place would have lasted for at least approximately 500 years. However, the results of the pollen analyses are in favor of a very short-lasting settlement. A comparison of Zeuner's dating with those made in Copenhagen makes it reasonable to assume that the date of the culture layer is very close to 2700 B.C. (in agreement with Zeuner's sample G1.18) and that the settlement existed for a very short period. Zeuner's sample G1.17 is beyond the age of the culture layer; this can be explained if a vertical pile, which easily may have been driven in at a later period, has been dated.
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13. Analyzed by Svend Jørgensen.
14. Drawn on the basis of analyses carried out by Svend Jørgensen and me.

Copenhagen Natural Radiocarbon Measurements II

Henrik Tauber

Archeological samples (*1*) from the earliest phases of the Neolithic period in Switzerland and Denmark were measured in the carbon-14 dating laboratory at Copenhagen during the period from February 1953 to May 1955 (*2*). All samples (Table 1) were excavated and submitted by J. Troels-Smith (*3*).

The Swiss samples originated from the neolithic lake dwelling Egolzwil 3, Wauwilermoos, Lucerne Canton. The settlement is of Older Cortaillod culture, and the samples were taken from a culture layer only a few inches thick and completely imbedded in sterile lake marl. The material used for the dating was wood, bark, and charcoal, which was very well preserved. The wood samples consisted of pieces of thin piles without bark; only the ten outer year-rings were used in the measurements (*4*). The settlement has been dated to the time immediately after the first strong beech fall in the Swiss pollen diagrams (*5*).

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The Danish samples were taken from a neolithic dwelling place Mul. I, in the bog Aamosen, West Zealand, and represent the earliest (phase A, predolmen) Neolithic period in Denmark (*6*). The cultural remains, which are of late Ertebølle culture, were deposited in a thin layer on a floating island of swamp peat. Between this former floating island and the gyttja layer of the bottom of the former lake was found a layer of washed-in drift mud 10 to 40 centimeters thick. The mud contained cultural remains, which are contemporaneous with the cultural deposits from the dwelling place. The samples consisted of well preserved bark, hazelnut shells, and charcoal, as well as swamp peat and drift mud. The time of the settlement coincides with the elm fall in the Danish pollen diagrams.

The samples were measured by using Libby's solid-carbon method as described previously by Anderson, Levi, and Tauber (*7*). Twice during the period of measurements the laboratory was contaminated by fallout from nuclear detonations (October and November 1954 and April and May 1955). All measurements made during these periods have been discarded.

The calculation of the dates is based on a half-life for carbon-14 of 5568 ± 30 years (*8*). The ages are given in the fixed time scale (B.C. and A.D.), and each figure represents a separate run. The errors assigned to the dates include the statistical error in the net count of the unknown sample (e_s), the statistical error in the measurement of the activity of modern wood (e_r) which is used as a reference, and the error in the half life of carbon-14 (e_h). The possible effect of industrial combustion on the activity of modern wood has not been taken into account; such an effect, if present in the area of

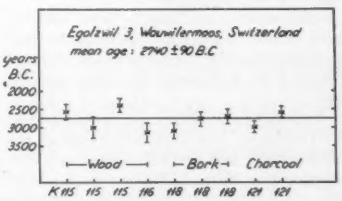

Fig. 1. Dating results from Switzerland.

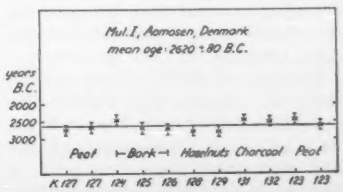

Fig. 2. Dating results from Denmark.

Table 1. Radiocarbon dates.

Description	Sample No.	Date (yr B.C.)
I. *Egolzwil 3 series, Switzerland*		
Spruce (*Abies alba* Mill., determined by B. Stüssi). Wood with no bark, placed horizontally in the middle of the western part of field II, 1952 (*5*). The wood was totally enclosed in the culture layer, which was locked up in lake marl. (E_s-101)	K-115	2560 ± 210 2990 ± 300 2380 ± 190 Average 2550 ± 150
Ash (*Fraxinus excelsior* L., determined by E. Tellerup). Piece of a thin pile with no bark; the wood had been attacked slightly by beetles. It was placed horizontally in field III, square 641, 1952 (*5*). Here the culture layer was hardly 1 cm thick, so the wood lay directly upon, and was covered by, lake marl. (E_s-105)	K-116	3130 ± 280
Bark from a large piece of lime bark (*Tilia* sp., determined by E. Tellerup). The large piece of bark was placed horizontally, with the outer side upward, in the northern part of field III, 1952 (*5*). The bark was placed directly on the lake marl and was covered by a culture layer about 1 in. thick. (E_s-81-84)	K-118	3080 ± 230 2760 ± 200 2690 ± 200 Average 2830 ± 140
Charcoal. Two samples of charcoal, the first of which consisted of 100 percent ash (*Fraxinus excelsior* L.), the second of 90 percent lime (*Tilia* sp.) and 10 percent elm (*Ulmus glabra* Huds.) (determined by E. Tellerup). The charcoal came from the lower part of field II, 1952 (*5*) and was totally enclosed in a 4-in. thick culture layer, which was placed upon and covered by lake marl. (E_s-111)	K-121	2970 ± 180 2570 ± 180 Average 2770 ± 130
Average date for the culture layer Egolzwill 3:		2740 ± 90
Lake marl. Sample situated immediately above the culture layer. The measurement was made on the inorganic carbon. The age has been calculated on the basis of the value for modern wood. (E_s-4)	K-119	3620 ± 170
Lake marl. Sample situated immediately underneath the culture layer. The measurement was made on the inorganic carbon. (E_s-7). Samples K-119 and K-120 indicate that "old" carbon has been incorporated into the lake marl and demonstrate that the dates obtained from lime samples should be treated with caution.	K-120	4350 ± 170
II. *Mul. I series, Denmark*		
A. *The dwelling place*		
Alderwood peat. Sample from immediately above the culture deposits. Slightly younger than the dwelling place. Position N5.25–5.50, E14.75–14.90. (Mul. I 16336 bø)	K-127	2730 ± 160 2670 ± 160 Average 2700 ± 120
Pieces of bark (*Alnus* sp., determined by E. Tellerup). The bark forms part of the culture layer and probably served as a covering of the floor. Cultural remains were found in and above the bark layer. Position N4.00–5.00, E6.75–7.25. (Mul. I 10711, 10712, 10703)	K-124 K-125 K-126	2450 ± 170 2690 ± 170 2730 ± 170 Average 2620 ± 120
Hazelnut shells. Found in the culture layer of the dwelling place. Position N7.00–10.00, E9.50–10.00. (Mul. I 178+)	K-128	2760 ± 160
Hazelnut shells. Found in the culture layer. Position N6.00–9.50, E11.00–11.50. (Mul. I 3361a+)	K-129	2790 ± 160
Charcoal (species not determined). Found in the culture layer. Position N6.00–10.00, E9.50–10.00. (Mul. I 165+)	K-131	2460 ± 150
Charcoal (species not determined). Found in the culture layer. Position N6.75–9.75, E6.50–9.50. (Mul. I 566+)	K-132	2510 ± 150
Average date of bark, hazelnut shells, and charcoal		2630 ± 80
Swamp peat. Found immediately underneath the culture deposits. Slightly older than the dwelling place. Position N9.25–9.50, E11.75–12.00 (Mul. I 11005)	K-123	2450 ± 150 2620 ± 150 Average 2530 ± 120
Average date for the dwelling place Mul. I		2620 ± 80
B. *Drift mud*		
Mud. Sample collected immediately above the layer of drift mud. Older than the dwelling place Mul. I. Position N13.00, E6.75. [Mul. I 26003 (II)]	K-148	3530 ± 170
Drift mud. Washed-in underneath the floating island, which was carrying the dwelling place. Taken immediately under the mud of sample K-148. Considered contemporary with the dwelling place. Position N13.00, E6.75. [Mul. I 26004 (III)]	K-137	3200 ± 160
Drift mud. Washed-in underneath the floating island. Placed immediately under the drift mud of sample K-137. Considered contemporary with the dwelling place. Position N13.00, E6.75. [Mul. I 26005 (IV)]	K-136	2970 ± 180
Calcareous mud. Located immediately underneath the drift mud of sample K-136. Only the organic fraction was used. Older than the dwelling place and slightly older than sample K-148. Position N13.00, E6.75. [Mul. I 26006 (V)]	K-149	3660 ± 180
Drift mud. Washed-in underneath the floating island. Considered contemporary with the dwelling place. Position N8.50, E11.75—that is, 4.5 m south and 5.0 m east of samples K-136 and K-137. (Mul. I 10715, 10716)	K-122	1830 ± 180 2260 ± 160 2090 ± 150 Average 2060 ± 110
Drift mud. Washed-in underneath the floating island. Considered contemporary with the dwelling place. Position N9.70, E6.20—that is, 3.3 m south and 0.5 m west of samples K-136 and K-137 (Mul. I 31177, 31178, 31179)	K-156	2850 ± 160

Copenhagen, would tend to make the ages slightly younger than the real ages of the samples.

The dating results from Egolzwil 3 and Mul. I are plotted in Figs. 1 and 2. The errors shown are statistical errors in the net count of the unknown samples (e_s) only; thus, from a statistical point of view, two-thirds of the dates should deviate less than the indicated error from the mean value. It is seen that the scattering of the dating results is in satisfactory agreement with statistics.

It can be concluded from the measurements that the early phases of Swiss and Danish Neolithic occurred almost simultaneously, the date of the lake dwelling Egolzwil 3 being 2740 ± 90 B.C., and that of the dwelling place Mul. I 2620 ± 80 B.C.

References and Notes

1. Samples suitable for carbon-14 dating are chosen by a committee consisting of Therkel Mathiassen (chairman), Helge Larsen and J. Troels-Smith, National Museum, Copenhagen, and Sigurd Hansen and Johs. Iversen, Danish Geological Survey (D.G.U.)

2. This work has been supported in part by grants from the Carlsberg Foundation and from the Danish State Research Foundation. I wish to express my sincere thanks to Hilde Levi for her continuous promotion of the work and to the

archeologists O. Voss, P. Kjærum, and E. Thorvildsen for their collaboration.
3. See the paper by J. Troels-Smith in this issue.
4. H. Levi and H. Tauber, in W. U. Guyan, Ed., *Das Pfahlbauproblem*. Monografien zur Ur- und Frühgeschichte der Schweiz, vol. 11 (Birkhäuser, Basel, 1955).
5. J. Troels-Smith, *ibid.*
6. ———, *Aarboger for Nordisk Oldkyndighed og Historie* (1953).
7. E. C. Anderson, H. Levi, H. Tauber, *Science* 118, 6 (1953).
8. W. F. Libby, *Radiocarbon Dating* (Univ. of Chicago Press, Chicago, 1952).

A. C. Kinsey, Zoologist

Alfred C. Kinsey, professor of zoology, Indiana University, and director of the Institute of Sex Research, died 25 August 1956, at the age of 62. Dr. Kinsey was born in Hoboken, New Jersey, 23 June 1894. His father was an engineer and taught at Stevens Institute, where Alfred later spent 2 years before deciding he did not want to be an engineer. He entered Bowdoin College, from which he graduated in 1916. While at Bowdoin and also in earlier years he worked in boys camps during the summer and acquired an interest in the out-of-doors and in living things, an interest that was incorporated into his high-school textbook on biology, published in 1926. After graduation from Bowdoin he entered Harvard Graduate School, where he studied with Merritt L. Fernald, William Morton Wheeler, W. E. Castle, and others. He was granted the Sc.D. degree in 1920. His last year, while he held a Sheldon traveling fellowship, was spent in the field collecting gall wasps. He jointed the faculty of Indiana University as assistant professor of zoology in September 1920 and rapidly advanced to the rank of professor in 1929.

During these earlier years at Indiana he continued his studies on gall wasps and published a series of papers on life-histories, taxonomy, geographic distribution, and evolution within the group. The most significant of these publications was on the origin of species in the genus *Cynips*, in which he defined a species as a population with common heredity. He was one of the first to correlate taxonomic studies with genetics.

Although Dr. Kinsey's interest in research was probably paramount, he was also a stimulating and provocative teacher. In advanced courses his method, where possible, was to permit students to reach their own conclusions from a study of specimens set before them or to learn as a result of their own efforts.

Dr. Kinsey's studies on gall wasps are now largely overshadowed by his more recent work on human sexual behavior, which he began in a small way in 1938 and continued without interruption until his death. His interest in this field was stimulated by students who came to him for counsel and advice on problems which he could not answer for lack of information. As he proceeded to find answers, his interest grew until finally the problems of sex became the dominant interest in his life. His approach from the beginning was that of a scientist seeking the truth, leaving moral and social implications to others. Gradually the immensity of the problems with their many ramifications and the difficulties of approach became apparent. It also became apparent that one man working alone could make but little progress toward solutions. With generous support, however, from Indiana University, the Committee on Problems of Sex of the National Research Council, the Rockefeller Foundation, and later from the income from the sale of his books, Dr. Kinsey was able to build a competent research staff without which progress would have been seriously handicapped.

From 1938 to 1947 Dr. Kinsey's researches on human sexual behavior were carried on within the department of zoology, but in 1947, for purposes of convenience and efficiency, the Institute for Sex Research was incorporated, and Dr. Kinsey was relieved of all teaching duties. He continued, however, to hold his professorship in the department.

Because of the scarcity of information, the greatest need at the beginning and throughout the study has been for more data, the facts of human sexual behavior. For collecting information, a personal-interview technique was developed, and the answers were recorded in code which could be read only by the few concerned with the research. To date 18,500 individual case-histories of men and women in various walks of life and from diverse regions of the United States have been recorded. Based on the information thus gained, two volumes, *Sexual Behavior in the Human Male* and *Sexual Behavior in the Human Female*, have been published, and others, including volumes on abortion, sex laws, and sex offenders and concepts of normality, are on the way or planned.

All studies, scientific or otherwise, in the field of human sexual behavior are certain to arouse criticisms because of diverse ways of looking at the subject, and Dr. Kinsey's studies have been no exception. But as time has passed and as emotion and prejudice have been replaced to some degree by sober thinking, the criticisms of Dr. Kinsey's research have become less bitter, and more supporters, realizing the values of the study, have come to its defense. Many of the criticisms came from persons who had not read the books and who did not want to read them. Some critics depended on newspaper and magazine articles which often distorted the truth. Criticisms based on misinformation and swayed by prejudice and emotion cannot be valid. Dr Kinsey, himself, was the most severe critic of his work from the scientific point of view. He did not pretend that he had the answers to all the problems. He realized the need for more data and better methods of analysis. If, however, he had waited until he had final answers to the problems, he would never have published. Science advances by degrees and can only approach solutions.

To demonstrate Dr. Kinsey's unselfish devotion to his work, it should be said that all income from the sale of his books, which were best sellers, was used to finance his research program.

Dr. Kinsey had interests other than university teaching and research on gall wasps and human sexual behavior, as is indicated by the publication of a high-school textbook in biology and the publication with Fernald of Harvard of a book on the *Edible Wild Plants of Eastern North America*. In his early years at Indiana he developed a beautiful garden in which he took special pride in his large collection of iris. Since boyhood he had had an interest in music and this interest was maintained throughout his life. He and Mrs. Kinsey collected a large series of records of classical music and invited their friends to their home for Sunday evening concerts. He was always a vivacious and entertaining host. Mankind is the loser by his untimely death, but what he has accomplished will live on. The gate to further knowledge has been opened and the path charted.

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News of Science

More Mutation in Males?

In connection with the report of Glass and Ritterhoff [*Science* **124**, 314 (17 Aug. 1956)] that mutations with visible effects in *Drosophila* are at least 10 times as frequent in the male germ line as in the female germ line, for the loci studied, it is significant that J. B. S. Haldane has on more than one occasion conjectured that the same relation might be true in the human species. In the *Annals of Human Genetics* (May 1956) he makes estimates of the mutation rate to the sex-linked recessive gene responsible for muscular dystrophy (of the Duchenne type). Although the data are scanty, the result of the estimate is that the mutation rate in the female parent can scarcely be higher, and more probably is considerably lower (1/6), than the rate in the male parent.

Similar and more extensive data for hemophilia led Haldane in 1947 to suggest that the same might be true for that harmful trait, but the accuracy of diagnosing women heterozygous for the trait, a necessary parameter of the calculation, has been called in question. At least there are these two cases with a suggestive similarity to the *Drosophila* data. Haldane emphasizes that "as the importance of mutation for the causation of disease is recognized, and the possibility of increase in human mutation rates as a result of atomic nuclear reactions is discussed, it becomes of interest to compare mutation rates in the human sexes."—B. G.

AEC-World Bank Agreement on Aid for Nuclear Power Plants Abroad

The U.S. Atomic Energy Commission and the Export-Import Bank of Washington, D.C., have agreed upon joint action to assist with the construction of atomic power plants in nations that enter into Agreements for Cooperation with the United States. The Export-Import Bank is prepared to consider loans to privately owned public-utility companies, as well as to governments, to finance the construction of atomic power plants abroad. The terms would be similar to those provided in its financing of conventional types of power plants where U.S. equipment and technical services are required. These developments will take place under the following general conditions.

1) Nations seeking financial as well as engineering assistance in construction of atomic power plants must have completed an Agreement for Cooperation with the United States, as provided in the Atomic Energy Act of 1954.

2) The Export-Import Bank will require (i) a comprehensive engineering survey of a project; (ii) a technical report by the AEC on the reactor part of a project; (iii) an arrangement for availability of atomic fuels, through lease or sale by the AEC, for the term of a loan; (iv) evidence of over-all financial and economic soundness of a project; (v) evidence of the availability of funds to defray the local currency costs of the projects; (vi) assurances on the ability of the country concerned to service the dollar debt involved.

3) Proceeds of the loan can be spent only for equipment, materials, and technical services to be exported from the United States.

NSF Surveys Nonprofit Research Institutes and Commercial Laboratories

The scientific research and development effort of nonprofit research institutes and commercial laboratories in 1953 amounted to an estimated $85 million and required the employment of about 5000 scientists and engineers, according to a new National Science Foundation report, *Research and Development by Nonprofit Research Institutes and Commercial Laboratories, 1953*. The report was prepared by the Maxwell Research Center, Syracuse University, and is a part of an over-all survey of the entire research and development effort in this country. It covers all the known nonprofit research institutes and a substantial sample of all the commercial laboratories.

A majority of this country's commercial laboratories and nonprofit research institutes have been founded since 1941. This rapid increase can be accounted for largely by the swift expansion of the Federal Government's research programs, particularly those of the military departments.

There is little significant difference between the research and development programs of the two types of organizations. In general, both types have been established to provide scientific services to industry and are oriented towards solving specific practical problems.

During 1953 commercial laboratories spent approximately $35 million for scientific research, of which about $4 million was for basic research; nonprofit research institutes spent more than $50 million for research, which included approximately $3 million for basic research.

The Federal Government contracted with the commercial laboratories for about half of their total research expenditures and industry sponsored the remainder, except for a small portion of funds derived from such sources as trade associations, foundations, and universities. In the case of the nonprofit research institutes, the Government contracted for approximately twice the volume of research and development financed by industry.

A copy of the NSF report may be obtained for 50 cents from the Superintendent of Documents, Washington 25, D.C.

Radiation Death

Radiation exposure caused the death of Kenneth A. Koerber, Philadelphia physician who worked in the Atomic Energy Commission's Brookhaven National Laboratories between 1946 and 1948, according to the finding of a recent inquest. An autopsy at the time of death last July failed to disclose the cause, and a second autopsy was ordered.

In Washington, a spokesman for the AEC said: "We have nothing showing that [Koerber] ever got a dose of radiation. He did not work with radioactive materials and was not exposed to them in the course of his work."

Joseph W. Spelman, medical examiner for the city of Philadelphia, has made the following statement:

"We presume that Dr. Koerber somehow got a dose of atomic radiation that now, ten years later, caused his death. We have conclusively proved that he was subject to atomic radiation or to the inhalation or to the eating of atomic compounds. At the present time his bones contain 1000 times the maximum safe concentration of radiation."

Part of Koerber's duties at Brookhaven was inspecting laboratories to protect the workers from radiation. Spelman said the radiation absorbed by

Koerber's body was probably a cumulative exposure instead of a single one. Koerber's remains have been sent to Argonne National Laboratory for further examination.

Survey of Atomic Scientists

A survey of scientific and engineering manpower needs in private atomic energy industries will be conducted by the Atomic Industrial Forum, Inc., of New York under a contract with the U.S. Atomic Energy Commission. Scheduled to begin immediately, the survey will cover current manpower supply and prospective needs in relation to the industry's privately supported atomic energy activities, as distinguished from work done under contract to the Government. Information will be sought from all firms known to be engaged in or planning atomic energy work. The survey's purpose is to develop direct, reliable information for the use of industry, colleges and universities, and the Government in planning action to relieve the shortage of atomic scientists and engineers.

The forum survey will be the first step in a four-part manpower study based on the principle that the rate of advancement of nuclear science and engineering in the United States depends on the availability, now and in coming years, of an adequate number of persons trained in engineering and in the physical, mathematical, and natural sciences. Other surveys will cover the manpower needs of industry; universities, colleges, and nonprofit research institutions; and the Government. The survey being carried out by the forum will require about 5 months for completion. Arrangements for conducting other surveys will be announced as they are made.

Solar Water Heat

The Soviet radio has reported that the Government of Soviet Azerbaijan has ordered the construction of 200 solar water-heating plants this year and 500 next year to heat water for baths and showers in medical institutions and government agricultural stations. This follows the success of two solar plants built near Baku last year. The plants were able to heat water to between 48° and 56°C during the summer and to 43°C in the winter.

Building Radioactive since 1951

A building in Cincinnati, Ohio, that was last occupied by Keleket, Inc., makers of x-ray equipment, has stood empty since 1951 because it was contaminated by the explosion of a capsule of radium. The premises were immediately washed down and contamined machinery was crated in lead and shipped to Oak Ridge, Tenn., for burial. Nevertheless, later workmen were able to detect radium dust in every corner. Last September when an application for permission to use the building as a rest home was received by the board of health, tests showed that the building was still dangerously radioactive.

Kettering Laboratories, which has examined the structure, has reported that eventually repeated scrubbings and time might render it safe for occupancy if some areas were buried in concrete and if a constant check for radioactivity were maintained. Keleket went to court soon after the accident and asked $200,000 from its insurance company. A ruling is still pending.

Rare Infant Disease Identified

An unusual kind of pneumonia, hitherto not known to exist in the United States, has recently been identified in a 21-month old infant born and reared in Connecticut. The disease was reported by Georges Dauzier, Thayer Willis, and Roy N. Barnett in a recent issue of the *American Journal of Clinical Pathology*. The authors are all members of the staff of the Norwalk Hospital, Norwalk, Conn.

The dangerous organisms, *pneumocystis carinii*, appear in the lungs under microscopic examination, but they have not been cultured or transmitted to animals. The disease caused by these tiny organisms, however, has been of considerable concern in Central Europe, where it is a leading cause of death among small babies. Discovery of its presence in the United States at this time may indicate a possible health hazard.

The symptoms are those of a severe pneumonia, but the disease resists all of the drugs ordinarily used in the treatment of pneumonia. Since publication of the study, cases have been identified in Chicago and Oklahoma. How infants become infected with this little-known organism is unknown.

Isotope Separation

Photochemical separation of mercury-198 from other mercury isotopes has been achieved through the use of a monoisotopic resonance lamp. Mercury and water vapor are passed in a stream of nitrogen over a lamp that utilizes only mercury-198 as a radiation source. As a result, mercury-198 atoms are selectively excited, and, when some of the material reacts in the presence of a hot wire precipitator, the yield of mercuric oxide is enriched by a factor of 1.5 with respect to the desired isotope.

According to Bruce Billings of Baird Associates–Atomic Instrument Company, to whom a patent on this process has been granted, similar techniques may be feasible for the separation of other isotope mixtures. He also stated that such methods may be applicable to the study of sensitized atoms in reaction.

Hamsters and the Common Cold

For what appears to be the first time, a hamster has been infected with a common cold. This makes the hamster the only animal other than the chimpanzee to be susceptible to the common cold, according to Reginald L. Reagan, Eddy Palmer, Frances S. Yancey, Sing Chen Chang, and A. L. Brueckner in an article in the September *Archives of Pathology*, published by the American Medical Association.

Four strains of cold virus (MR, C, RLR, and D) were taken from human beings. The viruses were given to suckling hamsters by nose. After from 3 to 7 days, several sucklings in each group given the viruses exhibited the typical symptoms of a cold. Other hamsters were exposed to the nose and throat washings from a person who had not had a cold in the past year. None of these animals caught colds. However, when they later received virus material from the hamsters with colds, they developed the typical signs. The hamsters that originally had colds did not develop them when given virus material a second time.

Dentistry in Western U.S.

The demand for dental care in the western states is expected to increase more rapidly than the number of practicing dentists and dental hygienists, according to a survey of 11 states by the U.S. Public Health Service, Department of Health, Education and Welfare. This report, the first of a series to be made throughout the nation, states that of the 95,000 dentists who are expected to be practicing in the United States by 1975, about 16,000 will be located in the western states. This would be an increase of 4000 over the number of dentists practicing in the West during 1955, but it still would not be a large enough number to meet the needs of the region's expected population growth. Although the proportion of dentists to population is still higher in the West than in the nation as a whole, it is now declining at a faster rate.

The survey was conducted by the USPHS Division of Dental Resources in cooperation with the Council on Dental

Education of the American Dental Association and the W. K. Kellogg Foundation. It was undertaken at the request of the Western Interstate Commission for Higher Education and published by the commission under the title "*Dental Manpower Requirements in the West.*" The survey covers Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, and also includes sections of the territories of Alaska and Hawaii.

New Electron Tube

A retarding-field oscillator, a new electron tube designed to operate at extremely high frequencies with large power outputs, has been developed by Ohio State University under a contract with the Wright Air Development Center of the Air Research and Development Command. The new tube operates at a frequency of 70,000 megacycles per second, and it has operated, with reduced power output, at 100,000 megacycles per second.

The tube is tunable, and it operates at lower voltage and with higher power output than tubes now on the market. Several rare metals are utilized in making the tubes. Gold is used as a solder; silver finds various uses because it has a low electric resistance; additional metals used include tungsten and tantalum, both of which have very high melting points. Sapphires are used for bearings.

News Briefs

■ The Audubon Society of Canada has come out strongly against current proposals to trap whooping cranes in the hope of breeding them in captivity. The society's executive director, John A. Livingston, said such a move would endanger the very existence of the cranes and that to remove any birds from the wild flock of 27 might so seriously alter the numerical level of the species that they could no longer maintain themselves in a natural state.

■ A helicopter has been flown into the fuming crater of Mount Ngauruhoe in New Zealand four times in order to deposit scientific instruments attached to cables that connect the volcano with an observation station 6 miles away. Seismologists are hoping to collect facts that will enable them to forecast the volcano's eruptions.

■ Prompt reporting of unusual or adverse reactions to drugs is the objective of a new joint study being carried on by 11 leading hospitals. The pilot reporting system, which is sponsored by the Food and Drug Administration, is being developed with the collaboration of the American Association of Medical Record Librarians, the American Society of Hospital Pharmacists, the American Medical Association, and the American Hospital Association.

■ Ancient pines, more than 4000 years old, have been found growing in the upper timberline of the White Mountains in eastern California by Edward Schulman of the University of Arizona Laboratory of Tree-Ring Research and his assistant, C. W. Ferguson, Jr. The trees are the oldest known living things, and exceed the age of the oldest dated giant sequoias of California by about 1000 years. The discovery is reported in a recent publication by Schulman titled *Dendroclimatic Changes in Semiarid America.*

Scientists in the News

GEORGE GAMOW, professor of physics at the University of Colorado, received the Kalinga prize from the director-general of the United Nations Educational, Scientific, and Cultural Organization in a brief ceremony that took place recently at United Nations Headquarters. The prize, awarded annually by UNESCO to a science writer selected by an international jury, was established in 1952 by B. Patnaik, of Cuttack, Orissa, India, for the dual purpose of recognizing outstanding interpretation of science to the general public and of strengthening scientific and cultural links between India and other nations. The winner receives a prize of 1000 pounds sterling and also is invited to the annual meeting of the Indian Science Congress and to spend a month visiting and lecturing in India.

LESTER LEWIS, an industrial physicist, has been appointed professor and chairman of the department of physics at Wagner College (Staten Island, N.Y.). In the past 18 years he has served as a physicist for the American Radio and Research Corporation, the General Electric Company, the National Bureau of Standards Textile Foundation, and the Radiation Laboratory at Massachusetts Institute of Technology.

FREDERICK SEITZ, professor of physics at the University of Illinois and chairman of the governing board of the American Institute of Physics, has been appointed to the National Bureau of Standards Statutory Visiting Committee. The visiting committee consists of five scientific and industrial leaders appointed by the Secretary of Commerce. Their function is to visit the bureau at least once a year and report to the Secretary "upon the efficiency of its scientific work and the condition of its equipment."

Appointed for a 5-year period, Seitz replaces J. H. VAN VLECK of Harvard University, whose term expired this year. The other members of the committee are M. J. KELLY, president of Bell Telephone Laboratories; CLYDE E. WILLIAMS, president of Battelle Memorial Institute; CRAWFORD H. GREENEWALT, president of E. I. duPont de Nemours and Company; and D. W. BRONK, president of the National Academy of Sciences.

CURTISS M. EVERTS of Portland, Ore., has been named by the Surgeon General of the U.S. Public Health Service to direct initial operation of the construction grants program authorized by the new Federal Water Pollution Control Act. This act provides for grants of $50 million during the current fiscal year to assist municipalities in the construction of sewage treatment works needed for pollution control and water conservation.

The program marks a new step by the Federal Government to further local and state efforts to control pollution of streams and conserve the nation's diminishing supply of usable water. Everts will be on leave from his duties as chief sanitary engineer of the Oregon State Board of Health.

PARK H. MILLER, JR., until recently professor of physics at the University of Pennsylvania, has joined the General Atomic Division of General Dynamics Corporation, San Diego, Calif.

PAUL H. HARVEY, professor and head of the department of field crops at North Carolina State College, has received the 1956 national award for distinguished service to agriculture that is sponsored annually by Gamma Sigma Delta, national honor society of agriculture.

HOWARD C. LUDWIG, of the metallurgy department staff at the new Westinghouse Research Laboratories near Pittsburgh, Pa., received the 1956 James A. Lincoln gold medal at the American Welding Society metal congress that took place recently in Cleveland, Ohio. The medal is awarded annually for the best paper presented at society conferences during the previous 12 months. Ludwig was honored for his work on "Metal transfer characteristics in gas shielded arc welding."

CHARLES M. MOTTLEY, formerly director of the planning division in the Office of the Assistant Secretary of Defense for Research and Development,

has joined the Washington, D.C. office of Stanford Research Institute. He will assist in broadening the scope of S.R.I.'s operations research program on the East Coast. In addition, he will aid in developing the institute's interests in medical and biological economics.

FRANK M. STRONG, biochemist at the University of Wisconsin, will deliver three of the 1956 series of the E. R. Squibb lectures at the Rutgers Institute of Microbiology. He will lecture on the general subject of "Adventures in microbial chemistry: Antimycin, CoA, Kinetin" on 5, 6, and 7 Dec.

DONOVAN S. CORRELL has joined the staff of the Texas Research Foundation, Renner, Tex., as chief botanist and head of the Botanical Laboratory. He was formerly principal botanist in the Plant Introduction Section of the U.S. Department of Agriculture, Beltsville, Md.

RICHARD T. WHITCOMB, aeronautical research scientist at the Langley Aeronautical Laboratory of the National Advisory Committee for Aeronautics, has received the NACA's highest award, the Distinguished Service Medal. He is the first person to receive the award since it was established last year. The citation said that Whitcomb "by his discovery and experimental verification of the Area Rule, accomplished in the period 1951–52 through the skillful use of the new NACA transonic wind tunnels, provided a novel and useful means of increasing, by as much as 25 per cent, and without additional power, the speed of airplanes in supersonic flight. . . .

The Area Rule provides a means of reducing the drag rise of airplanes that occurs at transonic and supersonic speeds.

Whitcomb found that when the combined cross-sectional area of wings, fuselage, tail, and other surfaces of the airplane is reduced, the drag rise is lowered substantially. In practice the design usually results in a narrow waist, or indentation, about mid-section of the aircraft fuselage.

The Area Rule was kept secret for security reasons from 1952 until September 1955, when the first planes using the concept went into production for the Air Force and Navy. Other high-speed military aircraft now under development incorporate the Area Rule design.

PAUL A. SIPLE recently left for Antarctica, where he will take charge of the scientific program at a base to be established at the South Geographical Pole. While at the pole he plans, by means of radio, to continue his activities as deputy to Rear Adm. Richard E. Byrd, officer in charge of the U.S. Antarctic Programs.

HARVEY BURSTEIN, who holds a law degree and who served with the Federal Bureau of Investigation for 6 years, has been named security officer at the Massachusetts Institute of Technology. He will be involved in the problems of security for the classified research work being done for the Federal Government, and also with the general problems of plant protection that are extensive in an institution as large as M.I.T.

ALFRED M. FREUDENTHAL, professor of civil engineering at Columbia University, has been awarded the 1956 medal of the Swedish Aeronautical Society. The presentation was made recently by Bo Lundberg, president of the Swedish Society of Engineers, at the Swedish Aeronautical Research Institute in Stockholm.

ROBERT S. MULLIKEN, physicist and expert on the spectra of molecules at the University of Chicago, has been named to the university's Ernest DeWitt Burton distinguished service professorship. Mulliken, who has been a member of the University of Chicago faculty since 1928, has specialized for the past 20 years in the study of the chemical bond of molecules, using spectroscopic methods. The professorship to which he has been appointed was established in honor of the third president of the University of Chicago and is one of a limited number of specially named chairs awarded for distinction in scholarship or science.

ROBERT W. SCHUMANN, formerly of Argonne National Laboratories, where he designed and developed the 256-channel analyzer, has been appointed chief development engineer of Radiation Counter Laboratories, Skokie, Ill.

R. M. BURNS, senior scientific adviser to the Stanford Research Institute, has been awarded the Acheson medal of the Electrochemical Society in recognition of his work on the corrosion of metals and his long-time participation and leadership in the affairs of the society. The medal and a $1000 prize are awarded every 2 years for notable contributions to the advancement of the society's objectives, purposes, and activities.

GEORGE P. FULTON, professor of biology, Boston University, College of Liberal Arts, has been appointed to succeed BRENTON R. LUTZ as chairman of the department of biology.

Inauguration exercises for the installation of ROBERT B. SMITH, JR., as fourth president of the Medical College of Virginia are scheduled for 17 Dec. Smith assumed the presidency on 1 July.

FLOYD A. ODELL, formerly deputy chief, biophysics division, Medical Directorate, Army Chemical Center, Md., has been appointed scientific director of the Army Medical Research Laboratory, Fort Knox, Ky.

The National Institute of Mental Health, Bethesda, Md., has announced the appointment of HAROLD M. HILDRETH as consulting psychologist in the Hospital Consultation Service of the Community Services Branch. Hildreth was formerly chief of the Clinical Psychology Division of the Veterans Administration.

JOHN E. BELL, formerly director of the Psychological Clinic at Clark University, where he was associate professor, is now with the NIMH as consultant in clinical psychology assigned to the San Francisco office of the Public Health Service.

WILLIAM M. HALES, formerly area chief psychologist in the area medical office of the Veterans Administration in St. Paul, Minn., has joined the staff of NIMH as consultant in clinical psychology. He has been assigned to the USPHS Dallas office.

Recent Deaths

MARK H. ADAMS, Huntington, L.I., N.Y.; 44; associate professor of biochemistry, New York University College of Medicine; member of AAAS editorial board; 17 Oct.

PAUL E. CARLINER, Baltimore, Md.; 46; codeveloper of Dramamine; 13 Oct.

HARRY N. FALK, Los Angeles, Calif.; 70; vice president of Baxter Laboratories; 9 Oct.

DAVID S. FAULKNER, Los Angeles, Calif.; 70; mechanical engineer and retired vice president of the National Supply Company; 11 Oct.

DENIS DE GOENCZ, Washingon, D.C.; 74; color chemist and pioneer in crush-resistant fabrics; 14 Oct.

TAYLOR B. GRANT, Chocorua, N.H.; 67; retired electrical engineer for the Bell Telephone Laboratories; 15 Oct.

AARON M. HAGEMAN, Verona, N.J.; 66; retired director of research, engineering, and equipment for the lamp division of the Westinghouse Corporation; 11 Oct.

SHORTRIDGE HARDESTY, Larchmont, N.Y.; 72; civil engineer and specialist in bridge designing; 17 Oct.

KENNETH S. JOHNSON, South Orange, N.J.; 71; retired engineer at the Bell Telephone Laboratories; 17 Oct.

HENRY R. KRAYBILL, Chicago, Ill.; 65; professorial lecturer in the de-

partment of biochemistry of the University of Chicago and director of the department of scientific research of the American Meat Institute; 30 Sept.

KATHRYN McHALE, Washington, D.C.; 67; former professor of psychology at Goucher College; 8 Oct.

MARY K. NICHOLAS, Spring Valley, N.Y.; 50; instructor in chemistry at the Jersey City Medical Center Nursing School; 13 Oct.

ROBERT B. OSGOOD, Boston, Mass.; 83; emeritus professor of orthopedic surgery at Harvard Medical School; 2 Oct.

JOHN C. PICKERING, Fort Lauderdale, Fla.; 73; retired mining engineer; 10 Oct.

ALICE M. RUSSELL, Philadelphia, Pa.; 65; head of the biology department at Rosemont College; 14 Oct.

EDWARD M. TWITMYER, Philadelphia, Pa.; 55; clinical psychologist; headmaster of the Pennsylvania School for the Deaf; 6 Oct.

JEREMIAH H. WALSH, Corning, N.Y.; 86; former secretary of the American Medical Association; instructor in anatomy at Rush Medical Center; 12 Oct.

Education

■ The Commonwealth of Massachusetts has appropriated $2,108,000 for a new four-story building at Lowell Technological Institute that will be used primarily to house the electronic and plastics engineering departments and the general engineering laboratories.

■ The Scripps Institution of Oceanography of the University of California has announced plans for expanding into other phases of science. Initial expansion will cost between $12 million and $15 million. The first steps will be to enlarge the departments of physics, chemistry, biology, geophysics, and research engineering.

■ A new laboratory for research in urology is to be established at Northwestern University Medical School. The laboratory has been made possible by the Lucy and Edwin Kretschmer Fund, which was created by the late Herman L. Kretschmer, urologist and former president of the American Medical Association, in honor of his wife and son. John Grayhack will be director of the new facility.

■ The natural science faculty of Newark College, Newark, N.J., a division of Rutgers University, in cooperation with the New Jersey Science Teachers Association, has scheduled a series of seven free lectures in the sciences for teachers.

■ The U.S. Public Health Service has announced the first grants, totaling $765,159, in its 3-year, $90-million program to assist in the construction of medical research facilities. Approval of the awards was based on the recommendation of the newly created National Advisory Council on Health Research Facilities, which recently held its first meeting at the National Institutes of Health in Bethesda, Md. The grants will be matched on a 50-50 basis by the institutions.

Some 24 additional applications were tentatively reviewed by the council. However, in order to have a better knowledge of the number and kind of applications which may be submitted, the council elected to act only on those projects for which full data were available and which warranted immediate support. It is expected that a major part of the $30 million available this year will be recommended for allocation at the December meeting of the council.

This first meeting was chiefly concerned with setting policies and organizing the new program. Regulations were recommended by the council and will be published soon in the *Federal Register*.

More than 250 institutions have asked for information and application forms for these construction grants. A list of the initial grants approved follows: Massachussets General Hospital, neurosurgical floor in the Warren Medical Building, $95,045; Albany Medical College of Union University, animal quarters, $45,000; Elizabeth Gamble Deaconess Home Association, operating the Christ Hospital Institute of Medical Research, Cincinnati, Ohio, construction and equipment of fourth floor in the Institute of Medical Research, $184,000; University of Pennsylvania, William H. Donner Center for Radiology, $179,004; University of Minnesota Medical School, department of anatomy research facilities, Jackson Hall, $26,110; University of Minnesota College of Medical Sciences, departments of physiological chemistry, physiology, and pharmacology research facilities, Millard Hall, $161,000; Georgetown University, animal research laboratories, $75,000.

Grants, Fellowships, and Awards

■ The National Science Foundation is initiating a program for the support of chemical research to be performed by qualified high-school and college chemistry teachers during the summer. Grants in support of such research will be awarded to colleges and universities that are interested in participating in this program, and they will select the high-school and college teachers who will conduct the research.

Proposals describing the research to be performed should be prepared along the lines suggested in the foundation's booklet, *Grants for Scientific Research*, copies of which are available upon request. The proposals should list the staff members of the chemistry department of the institution submitting the proposal, the name of the person who will supervise the research of the high-school and college teachers, and a description of the problems that will be studied.

In order to permit adequate time to arrange for the research to be conducted during the summer of 1957, it is planned to award grants in support of the selected proposals by about 1 Mar. 1957. The deadline for receipt of proposals to be considered is *1 Dec. 1956*. Proposals should be addressed to the Mathematical, Physical and Engineering Sciences Division, National Science Foundation, Washington 25, D.C.

■ Three fellowships are available at the Montefiore Hospital, Pittsburgh, Pa. These fellowships are designated by the donor, Bessie F. Anathan, for study or research in the medical sciences or in the basic sciences that contribute to the advancement of human health.

The fellowship committee will consider applicants, not only on the basis of high scholastic standing, but also on aptitude for research, without limiting the selection of fellows to residents of any area, and without regard to race, color, creed, or religion. For information, write to the Bessie Frank Anathan Fellowship Fund, Montefiore Hospital, Fifth Avenue at Darragh Street, Pittsburgh 13, Pa.

■ Applications are now open to college and university faculty members for places in the Oak Ridge Research Participation Program for 1957. Administered by the Oak Ridge Institute of Nuclear Studies in cooperation with Oak Ridge National Laboratory, the Research Participation Program is designed to disseminate scientific and technical information to educational institutions by enabling faculty members to spend varying amounts of time, usually the three summer months, conducting research in Oak Ridge laboratories. The participant's salary at Oak Ridge is equivalent to his university salary. Application blanks for summer appointments in 1957 may be obtained by writing to the University Relations Division, Oak Ridge Institute of Nuclear Studies, P.O. Box 117, Oak Ridge, Tenn. Forms must be returned *by 15 Dec.*

■ The training program for steroid biochemistry that is being sponsored by the National Institutes of Health for the Public Health Service [*Science* **124**, 482

(14 Sept. 1956)] has announced that the application date for postdoctoral and predoctoral awards will be extended from 1 Nov. to *15 Nov.* Inquiries should be sent to Dr. Frank Ungar, Worcester Foundation for Experimental Biology, Shrewsbury, Mass.

■ The National Science Foundation has announced the award of 50 postdoctoral fellowships for advanced study and research in the natural sciences. These were allocated during the second award period for postdoctoral fellowships. Of this group, 25 were senior postdoctoral fellowships for scientists who have held the doctoral degree for 5 years and have demonstrated unusual ability and special aptitude for productive scholarship. The remaining 25 awards were made in the foundation's regular postdoctoral fellowship program, primarily to recent recipients of the doctoral degree.

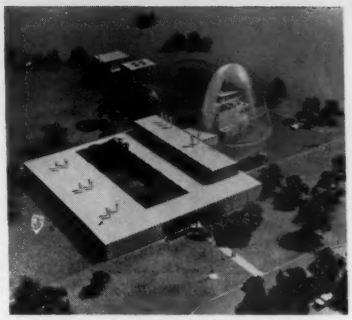
Twenty-two of the awards announced were in the life sciences, ten in chemistry, ten in physics, four in mathematics, two in earth sciences, one in engineering, and one in the area of convergence between the natural and social sciences. These fellowships are in addition to the 895 fellowships awarded by the foundation in March 1956. The National Science Foundation has reopened its senior postdoctoral program and its regular predoctoral and postdoctoral fellowship programs for additional awards for the academic year 1957–58.

In the Laboratories

■ The Laboratory of Microchemistry, Teaneck, N.J., founded by Carl Tiedcke, celebrated its 25th anniversary on 1 Nov.

■ The National Noise Abatement Council's first award for outstanding contributions to the field of noise control has been presented to Armour Research Foundation of Illinois Institute of Technology. A certificate of merit was presented during the recent National Noise Abatement Symposium in recognition of the foundation's noise control research and for its cooperation with the NNAC in originating the symposium "to foster the exchange of ideas in noise abatement technology." Armour's survey of city noises in Chicago during the middle 1940's was one of the first such studies to be made.

■ Ten corporations have formed a new company, Industrial Reactor Laboratories, Inc., to build and operate a privately owned nuclear reactor for industrial research in atomic energy at Plainsboro, N.J. The companies participating are Atlas Powder Company, AMF



Model of proposed plant for Industrial Reactor Laboratories, Inc.

Atomics Incorporated (subsidiary of American Machine and Foundry Company), American Tobacco Company, Continental Can Company, Corning Glass Works, National Distillers Products Corporation, National Lead Company, Radio Corporation of America, Socony Mobil Oil Company, and United States Rubber Company. Each participant is represented on the new company's board of directors, which will be headed by Gen. Walter Bedell Smith, president, and H. L. Hilyard, vice president; Smith is chairman and president of AMF Atomics, and Hilyard is treasurer of American Tobacco.

■ Because of the increasing number of inquiries on availability and prices of application-exempt quantities of radioisotopes, the U.S. Aomic Energy Commission Isotopes Division wrote to several commercial suppliers to request information on availability of iodine-131 and phosphorus-32. The division has prepared a leaflet listing the companies that plan to dispense application-exempt quantities of these materials. Several firms also make available application-exempt quantities of other radioisotopes. Other companies offering this type of service are invited to send data to the Isotopes Division, AEC, Oak Ridge, Tenn., for inclusion in revisions of the leaflet.

Miscellaneous

■ Interscience Publishers, Inc., New York, will be the United States agents for a new journal, *Nuclear Instruments,* that is to be published by the North-Holland Publishing Company, Amsterdam, the Netherlands. This journal on accelerators, instrumentation, and techniques in nuclear physics will be edited by K. Siegbahn of the Institute of Physics, University of Uppsala, Sweden, with the aid of a 38-member editorial board that consists of representatives from many different countries. The journal will be published bimonthly, beginning in November, and will contain original papers, short notes, survey articles, progress reports, news items, and book reviews.

The subscription rate is $17 a year for a volume of approximately 360 pages. Further information may be obtained from Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N.Y.

■ The University of Kansas has prepared a large nomograph for finding Ko_2 and Kco_2 of Warburg manometers over a range of 0 to 50°C and 0 to 6 ml of added fluid. Scientists may obtain copies, which measure 25 in. by 21 in., by sending a request to either Frederick E. Samson, Jr., or Nancy A. Dahl, Department of Physiology, University of Kansas, Lawrence, Kan.

■ The Institute of Laboratory Animal Resources (National Academy of Sciences–National Research Council), under a contract with the Cancer Chemotherapy National Service Center (National Cancer Institute) and in cooperation with commercial mouse breeders, is establishing a series of minimum standards for mouse breeding nutrition, distribution, sanitation, caging, and genetics. These standards will be used in a voluntary program of accreditation for breeders.

A Committee on Standards of the institute, under the chairmanship of T. C. Byerly, is supervising the definition of the standards. George L. Wolff of the Cancer Chemotherapy National Service Center has been assigned to the NAS–NRC to administer the program.

■ The November issue of *The Scientific Monthly* includes the following articles: "Seismology and the U.S. IGY program," A. P. Crary; "On going berserk: a neurochemical inquiry," Howard D. Fabing; "Path of atoms through generations," George Hevesy; "Social science techniques: a problem of power and responsibility," Edward Gross; "Chemical research and education in Japan," Bunichi Tamamushi.

In the "Science on the March" section appears a picture spread of the U.S. Naval Radiological Defense Laboratory in San Francisco. In addition, letters comment on the vanishing sea turtles, documentation in the service of science, and pseudonyms. Eight books are reviewed.

■ *Glycerine—Terms, Tests, Technical Data,* a new 19-page booklet describing the commercial grades, definitions, specifications, test methods, and shipping and storage requirements of glycerine, has just been issued by the Glycerine Producers' Association, 295 Madison Ave., New York 17, N.Y.

Reports

Mutations in Flax Rust Induced by Ultraviolet Radiation

A gene-for-gene relationship between rust reaction in flax and pathogenicity in the flax rust fungus, *Melampsora lini* (Pers.) Lév., has been postulated (*1*). For each gene that conditions the host's reaction, there is a specific gene that conditions pathogenicity in the parasite. Twenty-five pairs of genes have been identified, and a series of flax rust-differentiating varieties, each of which apparently possesses a single unique gene for rust reaction, has been developed (*1*, *2*).

The uredospore is the repeating and pathogenic phase of the flax rust fungus; it is dikaryotic. The ability of the rust to attack a flax variety (virulence) that possesses a gene for rust resistance has been inherited as a recessive character except in one case, the ability to attack the variety Williston Brown (*3*). Resistance to flax rust invariably has been dominant. For example, the Dakota variety possesses the genes for resistance *MM* and is not attacked by races either homozygous or heterozygous for the dominant gene for avirulence A_M but is attacked only by races homozygous for the recessive genes $a_M a_M$.

With radiation as the mutagenic agent, a uredospore homozygous for the genes conditioning avirulence on a variety carrying a single gene for resistance could attack that variety only if the identical genes in each of its two nuclei were hit. Probably such occurrences would be rare at sublethal dosages. On the other hand, a uredospore heterozygous for pathogenicity should be able to attack that variety following a single hit that altered its dominant gene. To test this possibility, race 1, which attacks only the varieties Williston Brown and Bison, was crossed with race 22, which attacks all differential varieties except Bombay and Stewart. In an earlier study (*3*) this culture of race 22 had been found to be homozygous for pathogenicity. If race 1 had been homozygous, the F_1 uredospores would have been heterozygous for pathogenicity on all the differential varieties that were resistant to race 1 and susceptible to race 22. However, selfing showed that race 1 was heterozygous for pathogenicity on four of the differential varieties. Each of the five F_1 cultures of race 22 × race 1 that were secured attacked at least two of the varieties for which race 1 was heterozygous. Culture race 22 × race 1-A was selected for study. This culture was homozygous for virulence on Akmolinsk, Bison, Williston Brown, and Victory A and for avirulence on Bombay and Stewart. It was heterozygous for pathogenicity and avirulent on Abyssinian, B. Golden selection, Barnes, Birio, Bowman, Cass, Clay, Dakota, Kenya, Koto, Leona, Ottawa 770B, Pale Blue Crimped, Polk, Towner, and Wilden.

With a camel's hair brush, spores were dusted on sized paper in thin layers. They were then exposed to ultraviolet radiation for 10 minutes at a distance of 4 inches from a 30-watt ultraviolet tube. About 10 percent of the spores survived this treatment.

Approximately 100 vigorously growing 12- to 18-inch plants of each of 22 flax varieties were inoculated by dusting a 1-to-40 dilution of the treated spores and talc. The spores were incubated 24 hours in a moist chamber and were then removed to a greenhouse bench. Uredia that developed on varieties resistant to the F_1 hybrid rust culture were increased either on the variety on which they developed or on Bison, and a pathogenicity determination was made on a complete set of rust-differentiating varieties.

It was estimated that one of the susceptible varieties bore about 40,000 primary uredia. Since at least one viable spore is required to initiate a uredial infection, each differential variety to which the culture was avirulent served as a screen for detecting mutations for virulence to its rust-conditioning gene in at least 40,000 spores.

Mutants were secured that attacked six of the varieties that were resistant to the nonirradiated uredospores. The reaction of these varieties to the mutant rust cultures is given in Table 1. The cultures that attacked Dakota, Cass, and Polk differed from race 22 × race 1-A only in ability to attack each of these varieties. This may be accounted for by the mutation of a single gene in each instance. Although no mutant culture was secured from Birio, the mutants from Barnes and Wilden attacked it. In previous studies on the inheritance of pathogenicity in the flax rust fungus (*1*, *3*), virulence to Birio was found to be independently inherited. Both Barnes and Wilden were susceptible to the parent races and to all hybrid cultures in the inheritance studies, so no information was obtained on the linkage relationships of the genes for pathogenicity to Barnes and Wilden with those for pathogenicity to other differential varieties. Each of the varieties Barnes, Birio, and Wilden has been susceptible to races of the flax rust fungus that do not attack the other two. Therefore it is probable that different genes in the parasite condition pathogenicity on each variety. The fact that Barnes, Birio, and Wilden were susceptible to both ultraviolet-induced mutant cultures suggests that the genes for pathogenicity to these varieties are so closely linked that a single hit altered all three genes. The occurrence of four or possibly five other groups of closely linked genes for pathogenicity has been reported (*1*).

The demonstration that it is possible by ultraviolet irradiation to produce mutations from avirulence to virulence in the flax rust fungus shows that muta-

Table 1. Reaction of flax varieties on which mutations for pathogenicity were observed to parent races, the F_1 hybrid, and mutants. The accession numbers are those of the Cereal Crops Section; *R*, resistant; *S*, susceptible.

Variety	Accession No.	Parent race		F_1 hybrid (Race 22 × race 1-A)	Mutants				
		1	22		Dakota	Cass	Polk	Wilden	Barnes
Dakota	1071	R	S	R	S	R	R	R	R
Cass	1182	R	S	R	R	S	R	R	R
Polk	1191	R	S	R	R	R	S	R	R
Birio	1085	R	S	R	R	R	R	S	S
Wilden	1193	R	S	R	R	R	R	S	S
Barnes	1190	R	S	R	R	R	R	S	S
No. of mutants having indicated pathogenicity					3	1	1	2	

tions are a factor in the development of new races. Other forms of radiation having greater penetration, such as x-rays and thermal neutrons, may be more effective mutagens. The methods used in these tests are readily adapted to screening large numbers of spores. Therefore it should be possible to determine the relative mutation rates of the genes that condition pathogenicity (*4*).

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4. This article is a contribution from the Field Crops Research Branch, Agricultural Research Service, U.S. Department of Agriculture, and from the North Dakota Agricultural Experiment Station.

23 July 1956

Effect of Free Radicals on Chromosomes of Barley

Early work on the radiation chemistry of water and aqueous solutions led investigators to conclude that the hydrogen peroxide found in such solutions might also be present in the cells of irradiated biological material and cause at least some of the genetic and physiological effects of radiation (*1*). This contention seems to have gained ground with the findings that organic peroxides and H_2O_2 increased the number of mutations in bacteria (*2*) and that the curves for inactivation of enzymes (carboxypeptidase) and production of H_2O_2 in irradiated aqueous solution were inversely related (*3*). Structural damage to chromosomes in *Tradescantia* microspores that had been irradiated with x-rays was attributed by Gray (*4*) to the effect of H_2O_2.

Recent investigations, however, indicate that hydrogen peroxide per se probably has little or no effect on the biological system and that it is the precursors of H_2O_2, H, OH, and HO_2, that produce the effect sometimes ascribed to H_2O_2. Barron *et al.* (*5*) found the effect of H_2O_2 on cell metabolism, proteins, and enzymes to be negligible unless the concentration was far above that found in the cytoplasm of irradiated cells. They asserted that a large number of cellular oxidations that had previously been traced to H_2O_2 were actually caused by free radicals evolved by the action of catalytic amounts of Cu^+ and Fe^{++} on H_2O_2.

Weiss (*6*) was one of the first workers to ascribe biological significance to radiochemically excited H, OH, and HO_2 radicals, suggesting that such radicals (especially OH) could be considered as the reactive entities in the target theory of mutation and chromosome breakage. Since that time, the role of the various radicals in biological systems has received considerable attention in the literature. Scholes and Weiss (*7*) noted fragmentation of the polynucleotides and increase in titratable acid groups when deoxyribonucleic acid was treated with chemically and radiochemically derived HO_2 radicals. Collinson *et al.* (*8*) showed that OH radicals completely inactivated solutions of ribonuclease.

This study (*9*) was designed primarily to assess the relative effects of H_2O_2 and free radicals on chromosome breakage. Of secondary interest was a comparison of the types of aberrations induced in this experiment with those produced by irradiation on the one hand and by radiomimetic substances on the other. Dormant barley seeds, variety Himalaya, were exposed to H, OH, and HO_2 radicals produced by combining dilute solutions of hydrogen peroxide and ferric sulfate. The seeds were treated for 16 hours and germinated on blotting paper. After fixation in Carnoy III (3 parts ethanol, 4 parts chloroform, and 1 part acetic acid), acetocarmine smears of shoot tips were examined cytologically for chromosome bridges and fragments at late anaphase of the first cycle of mitoses. Photomicrographs of such aberrations may be seen in Caldecott and Smith (*10*). Table 1 presents a condensed summary of numbers of chromosomal aberrations in the four treatments. Three concentrations of H_2O_2 (2, 4, and 6 percent), two concentrations of $Fe_2(SO_4)_3$ (0.01 and 0.1 percent), and the six resultant combinations of H_2O_2 and $Fe_2(SO_4)_3$ (2 percent H_2O_2 and 0.01 percent $Fe_2(SO_4)_3$; 4 percent H_2O_2 and 0.01 percent $Fe_2(SO_4)_3$; and so forth) were used, but since the differences between subtreatments were not significant, they have been combined in Table 1.

As indicated in Table 1, the frequency of chromosome fragments in the seeds treated with hydrogen peroxide and ferric sulfate is 15 to 20 times the frequency found in those treated with either hydrogen peroxide or ferric sulfate alone. It is quite clear that while hydrogen peroxide may play a minor role in chromosome fragmentation [even the small increase in fragment frequency owing to peroxide as compared with the H_2O control might be due to free radicals arising from the splitting of H_2O_2 by endogenous catalysts in the seed (*5*)] the preponderance of bridges and fragments must have been caused by the free radicals derived from the catalytic splitting of the H_2O_2 molecule.

Since H radicals will either combine in pairs to form molecular hydrogen or combine with O_2 to form HO_2 (*11*), it is the OH and HO_2 radicals that must be responsible for the observed effect. Both of these free radicals have been shown to degradate nucleic acids, nucleotides, and nucleosides (*1*).

Table 1. Chromosome bridges and fragments resulting from treatment of barley seeds in H_2O_2, $Fe_2(SO_4)_3$, and H_2O_2 and $Fe_2(SO_4)_3$.

Treatment	Cells (No.)	Bridges (No.)	Fragments (No.)	Fragments/cell
H_2O (control)	400	0	1	0.0025
H_2O_2	1200	0	6	0.005
$Fe_2(SO_4)_3$	800	0	3	0.00375
H_2O_2 and $Fe_2(SO_4)_3$	2400	13	211	0.0875

In order to assess fully the relative frequencies of chromosome and chromatid breaks, one must score cells for types of reunion as seen at metaphase as well as at anaphase. As mentioned in a previous paragraph, chromosome as well as chromatid breakage was estimated from bridge and fragment frequency at anaphase only. But by assuming that paired acentric fragments and paired dicentric bridges reflect a chromosome break, and that single fragments (or single, isolated fragments when there is more than one fragment in a cell) and single bridges indicate origin in a chromatid break, an approximation of the relative frequencies of chromosomes and chromatid breaks can be made.

Based on this assumption, 39 percent of the induced aberrations were of the chromosome type and 61 percent were chromatid breaks. This relationship of chromosome-chromatid breakage is more typical of that induced by x-irradiation than that caused by other radiomimetic chemicals (*3, 12*). Most chemicals have been found to inhibit or upset DNA synthesis, the result becoming manifest as chromosome breaks. The action of x-rays takes place later in interphase of the mitotic cycle after chromosome reduplication and results in a predominance of chromatid breaks (*13*).

This experiment produced two results that seem to be of particular interest. (i) Whereas H_2O_2 per se was shown to be ineffective in causing chromosomal aberrations, the treatment by the free radical precursors of H_2O_2 resulted in chromosome breakage. (ii) Chemically derived free radicals have much the same effect as x-irradiation in the production of chromosome aberrations. This aspect gains importance in the light of recent studies that attribute a major role to organic and inorganic free radicals in the x-ray induction of

mutations and chromosome damage. The action of these irradiation by-products (indirect effect) is becoming increasingly important in explaining irradiation phenomena that were once attributed solely to a direct effect (target theory) of ionizing radiation.

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13 July 1956

Larval Stages and Phylogeny as Exemplified by the Lung Fluke of Turtles

Embryonic and larval forms as clues to relationships have been criticized largely because their application to phylogeny has been misinterpreted as acceptance of the recapitulation hypothesis of Haeckel. That larval stages may be highly specialized has been well established but, as de Beer (*1*) has stated, "although it can in many cases be shown that these larval forms could not represent the adult ancestral forms, this does not detract from their value as evidence of affinity between the organisms that possess any particular type." That such value not only applies to relationships between phyla and classes but also may extend to less inclusive categories as well is shown in a striking manner by the digenetic trematodes. A larval stage common to all of them is the cercaria (cercariaeum, if tailless) of which there are several types. The discovery that certain very similar adult trematodes have utterly different types of cercariae and that very dissimilar adults may have the same larval type has required drastic revision of existing concepts of relationships and phylogeny within the group. For example, immature stages have demonstrated that trematodes once thought to form a single family, the Heterophyidae, actually belong to three families in two orders (*2*). On the other hand, life-history studies promise to consolidate major groups and, more importantly, indicate lines of descent among them.

It thus was particularly desirable to investigate the life-history of *Heronimus chelydrae,* a common parasite in the lungs of fresh-water turtles and so different from other trematodes that it has long been the sole occupant of a distinct family. It has been found that the miracidium penetrates *Physa* sp. and develops into a sporocyst which produces cercariae directly without the interpolation of an intermediate sporocyst or redial generation, as is the case in most known life-histories. The cercaria differs from the larvae of the paramphistomes only in lacking eyespots and possessing a pair of flame cell groups in the tail. However, these differences are known to occur in larvae belonging to the same superfamily, and the fundamental resemblances between the cercaria of *H. chelydrae* and that of the paramphistomes, especially in the embryology and form of the excretory system, justify the allocation of that species to the superfamily Paramphistomatoidea. The cercaria has a powerful ventral sucker which disappears before the adult stage is attained, and the unique features of that stage, notably the unusual position of the excretory pore and form of the genital glands, may be attributed to differential growth after the cercaria leaves the snail.

From the phylogenetic standpoint, the cercaria of the turtle lung fluke is of much interest. The presence of flame cells in the tail, the posterior position of the definitive excretory pores in that structure, the thin-walled excretory vesicle, and absence of an intermediate generation in the molluscan host are all characteristics that in combination have been reported only for certain fork-tailed cercariae, the larvae of the order Strigeatoidea. Although the amphistomes have been placed heretofore in the order Prosostomata, they thus may be the extant group closest to the trematodes from which the two orders evolved. Furthermore, the life-history of *H. chelydrae* lends support to the view that the fasciolids, echinostomes, and many monostomes, as well as the paramphistomes, trematodes that have never fitted comfortably into the Prosostomata, actually are closer to the Strigeatoidea.

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17 September 1956

Effects of Certain 19-Nor Steroids on Reproductive Processes in Animals

In previous publications we have reported that progesterone and certain of its chemical relatives are effective inhibitors of ovulation in rabbits, rats, and women (*1–4*). Among the most potent of a large number of compounds tested in animals have been a series of 19-nor steroids. These have proved to be effective ovulation-inhibitors by both oral and parenteral routes of administration. We have recently concentrated our attention on four of these compounds in a series of studies designed to reveal their action in various mammalian reproductive processes (*5*). The compounds are 17α-ethinyl-19-nortestosterone (I), 17α-ethinyl-5(10)-estraeneolone (II), 17α-ethyl-19-nortestosterone (III), and 17α-methyl-19-nortestosterone (IV).

The following assays with progesterone and these compounds have been performed in female mammals: (A) the Clauberg assay for endometrial stimulation in immature female rabbits, (B) the Rubin assay for uterotrophic activity in immature mice, (C) the deciduomagenic activity in primed, ovariectomized rats, (D) the conception-inhibiting activity in mature female rats caged with fertile males, (E) the ovulation-inhibiting activity in postpartum female rabbits mated to fertile males, and (F) the ability to induce and sustain implantation of the fertilized ovum in female rabbits castrated 1 day after a fertile mating. The details of the methods employed in these assays are being published elsewhere (*6*). In Table 1 we present the calculated minimum effective dose (M.E.D.) in each of the tests. Except where noted in the table, subcutaneous administration of the compounds was practiced.

The data demonstrate, first of all, that each of these compounds possesses progestational activity by virtue of its ability to induce pseudopregnant proliferation in the Clauberg assay (A). Of them II has approximately one-half of the activity of progesterone, whereas I, III, and IV are 5 to 10 times as active.

All of the substances are uterotrophic (B), but they exhibit marked quantitative differences, II being approximately 350 to 400 times as active as progesterone, and III, I, and IV being intermediate in activity. Actually there is a qualitative difference between these compounds in this test in the sense that the slope of the dosage/response curve for I, III, and IV resembles that of progesterone, whereas that of II more nearly resembles that of estrone, and comparison of the curves gives II an activity equivalent to one-fortieth to one-eightieth of that of estrone (*6*). In the spayed female rat test

for estrogenic activity, II has this same order of activity, whereas III is inactive.

We have been unable to demonstrate deciduomagenic activity (C) of I in doses up to 10 mg and of II in doses up to 15 mg. Compound III is about 4 times as active as progesterone, and IV has the same activity as progesterone.

Our best means of comparing the conception-inhibiting action of these compounds in rats (D) is on the basis of oral administration. Compound II is the most active of the substances studied. It should be pointed out, however, that progesterone given by mouth does not exhibit a true dosage/response curve over the range 2 to 50 mg (*2*, *4*), whereas by subcutaneous injection it does and exhibits an M.E.D. of less than 5 mg. The means whereby conception is inhibited by II in the rat appears to be dual in nature. In certain animals a clear inhibition of ovulation has been determined by inspection of the ovaries and noting the failure to form corpora lutea. In other animals ovulation was observed, but fertilization failed to occur. This is reminiscent of the inhibition of fertilization by progesterone administration in artificially ovulated rabbits reported by Dutt and Casida (*8*).

All of these compounds are effective inhibitors of ovulation in the rabbit. Although accurate quantification of this effect is difficult, the data of Table 1 (E) suggest that I and II are the most active in this test and that III and IV have the order of magnitude of activity of progesterone. We have previously reported that certain compounds active in this test in the rabbit may be inactive as conception-inhibitors in the rat (*4*). In this instance activity is exhibited in both species.

By their activity in the Clauberg test, these 19-nor compounds would be classed as progestins. One would expect, therefore, that they, like progesterone, should be effective in maintaining pregnancy. Actually, as is evident from the data of Table 1 (F), this is not completely demonstrable. Thus in doses up to 2 mg per day per rabbit II fails to induce implantation; III acts very much like progesterone, but a somewhat higher dosage is required. Compound I has behaved very peculiarly in this test. Tested at the 0.25-mg-per-day level it has induced implantation, albeit accompanied by much fetal degeneration. At dosages up to 10 mg per day very limited implantation has occurred in one-fourth of the animals and no implantation in the remaining three-fourths. We have no adequate explanation for this phenomenon but have considered the possibility that among the various effects exerted there may be combined in one molecule both progestational and antiprogestational potentialities. We have not been able to test this with I, but certain experiments conducted with II are suggestive. Rabbits pretreated with II for 3 days were mated to fertile bucks; at the same time ovulation was insured by the intravenous injection of a pituitary gonadotrophic extract. Examination of the tubal ova of several females indicated that most of the ova were fertilized. Nonetheless, in no instance were young born of such rabbits, and palpation failed to disclose normal implantation.

When administered to fertile female rats in 2-mg dose every other day for 70 days, II completely inhibited fertility during the period of administration, although matings occurred with males kept with the females. Following withdrawal of administration, a sterile period ensued which averaged 26 days in length. Examination of the daily vaginal smears disclosed fairly regular vaginal cycles as well as mating, suggesting that II did not alter completely the fundamental endogenous secretory rhythm but affected either ovulation or ovum development.

On the basis of these animal studies, we find here a group of substances which, by reason of certain similarities to progesterone, may be classified as progestins. Only one of them, 17α-ethyl-19-nortestosterone (III), appears to have typical progesteronelike activity in all of the tests employed, but it is quantitatively more active than progesterone in certain tests (for example, A and C) and less active than progesterone in others (for example, F). With these compounds one may inhibit normal reproductive processes in one aspect (for example, ovulation) or stimulate them in others (for example, endometrial proliferation). The fact that certain of them are active at quite low concentrations suggests potential therapeutic usefulness.

Table 1. A comparison of estimated minimal active doses of progesterone and the 19-nor steroids in six tests of activity.

Compound	(A) M.E.D. in Clauberg assays (mg)	(B) Minimum uterotrophic dose in mice (μg)	(C) Minimum deciduomagenic dose in rats (mg)	(D) Minimum oral antifertility dose in fertile rats (mg)	(E) Minimum ovulation-inhibiting dose (mg)	(F) Minimum implantation sustaining dose in rabbits (mg/day)
Progesterone	1–2	87	2	5–10+	1–2	0.5–1.5
I	0.1–0.2	29	> 10	5	0.25	0.25*
II	2–4	0.24	> 15	2	> 0.2 < 1.0	> 2.0
III	0.1–0.2	± 100†	0.5	5	> 1.0 < 5.0	2.0
IV	0.1+	19	2	Not studied	0.5–2.0	Not studied

* Less active at higher dose. † Data of Drill, Saunders, and Edgren (*7*).

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6 September 1956

Effects of Certain 19-Nor Steroids on the Normal Human Menstrual Cycle

In an accompanying paper (*1*) are described the effects evoked by certain 19-nor steroids on the reproductive processes of rodents. The present report deals with three of these compounds, 17α-ethinyl-19-nortestosterone (I), 17α-ethinyl-5(10)-estraeneolone (II), and 17α-ethyl-19-nortestosterone (III) (*2*). These were administered by mouth in dosages of 5 to 50 mg per day to 50 women from days 5 through 25 of the menstrual cycle. The subjects' ages ranged from 22 to 39 years (average, mean, and mode, all about 29 years).

During treatment, only rare instances of moderate side-effects occurred. Medication was given for inexplicable childlessness, since previous use of progesterone in high dosages had been helpful (*3*). On the basis of past history, these patients were known to ovulate regularly and, hence, to menstruate regularly and normally. During most con-

Table 1. Effects of 17α-ethinyl-19-nortestosterone (I), 17α-ethinyl-5(10)-estraeneolone (II), and 17α-ethyl-19-nortestosterone (III) on cycle lengths and indices of ovulation in normally ovulating women.

Compound and dosage (mg/day)	No. of cycles	Mean cycle length (days)	Incidence of ovulation										
			Basal temp.			Endometrial biopsy			Vaginal smear			Pregnanediol (mg/day)	
			(No.)	(% ±)	(% −)	(No.)	(% ±)	(% −)	(No.)	(% ±)	(% −)	(No.)	(Mean)
Control	40	27.2 ± 0.51	39	6	6	37	0	0	31	3	0	35	3.4 ± 0.27
(I) 10	21	28.9 ± 5.56	20	5	95	21	14	86	20	25	75	20	0.24 ± 0.037
(I) 20	36	28.6 ± 0.57	36	3	89	25	20	76	35	17	83	32	0.35 ± 0.073
(I) 40	5	26.8 ± 1.16	5	0	100	4	50	25	4	0	100	3	0.97 ± 0.97
(I) 10–40	62	28.5 ± 0.68	61	3	92	50	20	76	59	19	81	55	0.34 ± 0.066
(II) 10	28	26.5 ± 0.58	28	14	79	22	0	96	26	19	65	26	0.25 ± 0.052
(II) 20	6	27.7 ± 0.26	6	0	100	6	0	83	6	0	100	6	0.53 ± 0.335
(II) 10–20	34	26.7 ± 0.48	34	12	82	28	0	93	32	16	72	32	0.30 ± 0.074
Control	10	25.7 ± 0.91	9	10	0	11	0	0	8	0	0	10	3.1 ± 0.23
(III) 10–50	16	25.3 ± 2.24	13	0	100	11	0	91	10	0	100	10	0.31 ± 0.038

trol cycles, and ordinarily throughout one or more succeeding cycles of treatment, a careful study was made of (i) length of menstrual cycle; (ii) daily basal body temperature; (iii) endometrial biopsy (within cycle-days 19–24); (iv) daily vaginal smear; (v) 48-hour pregnanediol excretion (within cycle-days 17–23). Creatinine values indicated that these collections were complete. Analytic methods are described elsewhere (*4*).

From ii, iii, and iv, indirect diagnoses of the incidence of ovulation were made, the data in each category being classified as positive (+), doubtful (±), or negative (−), for ovulation. From the values of v, the degree of corpus-luteum activity was deduced (*5*).

In Table 1 are summarized the data in 50 control cycles of 50 subjects and in 112 medication cycles of 48 of these same women. Two are omitted from this presentation but are included in other reports (*4, 6*). They were given only 5 mg per day of compound I, which is now considered below the minimal effective dose. The subjects receiving I and II are regarded as a single group, hence their control values are averaged, for these compounds had almost identical effects. The test values i to v for each dosage in treated cycles are also averaged, since these women were sufficiently alike in pertinent respects.

By any single indirect criterion, doubtful or negative diagnoses for ovulation occurred in only minor percentages of the control cycles. If any two positive indirect criteria of ovulation are considered sufficient, 100 percent of the control cycles were ovulatory. In contrast, doubtful or negative indices of ovulation characterized the great majority of medication cycles, regardless of which of the three compounds was used. With compound III, there was interim spotting or break-through bleeding during treatment in eight of 16 cycles, without relation to dosage. Endometrial biopsies in these eight cycles disclosed hypoplasia, as though a needed estrogen were lacking.

In two cycles, subjects receiving II gave a positive sign of ovulation by each of two indirect criteria, so they might have been adjudged ovulatory, but the excretion of pregnanediol in each instance was 0.2 mg per day, indicating that even had ovulation occurred, corpus-luteum secretion was, at least largely, inhibited.

The nature of the endometrial histology is described elsewhere (*4, 6*). It suffices here to say that both I and II appear strongly to stimulate stromal development, even occasionally to a decidual stage, but endometrial glands do not function proportionately. Furthermore the mucosa is thin.

The mean data on pregnanediol excretion among all patients in the first, second, and third treated cycles, at each dosage-level of each compound, indicate a consistent and significant depression of output. Only two cycles with I and II, respectively, exhibited excretion values lying within two standard deviations of the mean control value, but in these cycles, the indirect criteria were negative for ovulation. Moreover, it is noteworthy that in seven cases of required laparotomy in patients who had previously taken compound I from 1 to 3 months, no recent corpora lutea were seen. In five of these instances, the observations in gross were confirmed by microscopic examination of ovarian tissue.

A follow-up has been possible for from 1 to 3 months after medication in 28 of the subjects who had taken compounds I and II. Although detailed analyses of these untreated cycles have not been feasible, each subject furnished us with postmedication basal temperature charts, which have been studied for ovulation time and cycle length. The relevant data are presented in another publication (*4*). They demonstrate (i) a statistically significant increase (of not more than 8 days) in the mean length of the first posttreatment cycles in both medication groups, and in the second cycle after therapy with I; (ii) a return to normal mean cycle length in the second and third postmedication cycles in subjects receiving II; (iii) a significantly delayed mean ovulation time in the first postmedication cycle in the case of both compounds, with a return to a normal mean time thereafter. In first and second postmedication cycles, there is a slight (statistically insignificant) increase in the percentage of doubtful ovulations over that in the control cycles. Observations made in posttreatment cycles showed that medication did not prevent a return of ovulation to any appreciable extent. When cycle prolongation occurred, it was the result of delayed ovulation. This suggests the need of a latent period of several days for complete ovarian recuperation.

The results, as shown in Table 1, indicate that all three compounds are effective ovulation-inhibitors in women. In dosages of 10 mg per day and higher, I and II, by their intrinsic action on the endometrium and/or by their only partial suppression of ovarian secretion, can maintain the endometrium in such a state that a catamenialike withdrawal bleeding occurs after cessation of therapy. In contrast, III, at dosages up to 50 mg per day, fails to exhibit such support in half of the cases studied.

Except for four habitual aborters, as well as for three patients with secondary infertility and one with primary infertility, who had been exposed to conception for not more than 1.5 years, exposure had prevailed for 2 to 10 years. Ten women with infertile exposure of 2 to 6 years had been previously pregnant. None of the 32 others had ever conceived, although their average exposure was 5 to 6 years.

Despite adequate coitus, none of the 50 women became pregnant during the months of medication. Their long-standing infertility may make this zero figure of no import. Nevertheless, it seems of at least passing interest that within only 5 months of the last treated cycle, seven patients conceived. Two of these, however, had secondary infertility, and each had been exposed for only 1.5 years. The remaining five had been inexplicably

barren for 3, 4.5, 4.5, 5, and 6 years, respectively. Hence in these seven instances, at least, it appears that the steroids not only did not damage the ovaries but, on the contrary, may have been helpful in the relief of sterility (*7*, *8*).

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Aftereffect in the Degradation of Cellulose and Pectin by Gamma Rays

Desoxyribonucleic acid is degraded by x-rays, and after the termination of irradiation a further degradation occurs (*1*). The latter phenomenon has been called an "aftereffect." Similarly, an aftereffect has been observed in the irradiation inactivation of trypsin (*2*), pepsin (*3*), and bacteriophage (*4*). The present communication (*5*) describes an aftereffect in the degradation of cellulose and pectin by gamma rays.

Solka Floc (Brown Company BW-200), which is a purified wood cellulose containing approximately 99.5 percent alpha-cellulose, and NF Citrus Pectin, a highly purified product used for pharmaceutical purposes, were chosen for these studies. The air-dry samples were reduced to lower moisture contents by being placed over phosphorus pentoxide in a desiccator which was evacuated by a Hyvac oil pump for periods up to 120 hours. Moisture contents were determined by the loss in weight at 70°C for 6 hours at 100 mm pressure. Samples that were heated were not used in further studies.

Solka Floc and pectin were placed in screw-cap glass vials and exposed to gamma radiation from cobalt-60. The dosages were controlled by placing the samples at fixed distances from the source for known periods of time, as has been previously described (*6*).

An estimate of the degradation of these samples was obtained from solution viscosity measurements in Ostwald-Cannon-Fenske viscometers at 25°C for cellulose and 30°C for pectin. Cellulose solutions were made up in cuprietheylenediamine which was 0.5*M* with respect to copper and in which the ratio of ethylenediamine to copper was 2/1 (*7*). Intrinsic viscosities were obtained by plotting η_{sp}/C as a function of the concentration, C (0.250, 0.125, and 0.0625 g/100 ml), and extrapolating the lines to zero concentration. Relative viscosities were determined for pectin at a concentration of 0.100 g/100 ml in a solution containing 0.2 percent Calgon and 0.8 percent sodium chloride and adjusted to *p*H 6.0 (*8*). In order to determine the primary effect of radiation, the viscosities of the irradiated and control (unirradiated) samples were measured as soon as possible after the end of irradiation. The solid samples were stored in vials at room temperature until they were needed for subsequent viscosity determinations.

Cellulose (*9*) and pectin (*8*, *10*) are known to be degraded by ionizing radiation, and the extent of degradation (percentage change in viscosity) as measured immediately after the irradiation is proportional to the log of gamma-ray dosage (*8*, *11*). To our knowledge, no aftereffect has been described for any polysaccharides.

The results in Fig. 1 were obtained on cellulose and pectin at moisture contents of 0.32 percent and 0.75 percent, respectively, irradiated in air. The degradation continued in the solid (dry) samples beyond that indicated by solution viscosities determined as soon as practicable after irradiation. With both polysaccharides, the aftereffect continued for at least 2 weeks, after which it became difficult to distinguish between small changes and experimental variations. In the specific instances illustrated, the aftereffect amounted to 106 percent and 25 percent of the primary effect for cellulose and pectin, respectively. The apparent dissimilarity is in part due to the fact that the particular dosage for cellulose (103.5×10^3 r) is much smaller than that for pectin (2030.0×10^3 r) so that in the case of cellulose the primary effect was relatively small. Thus, for example, at 552.3×10^3 r the aftereffect for cellulose was 59 percent of the primary effect.

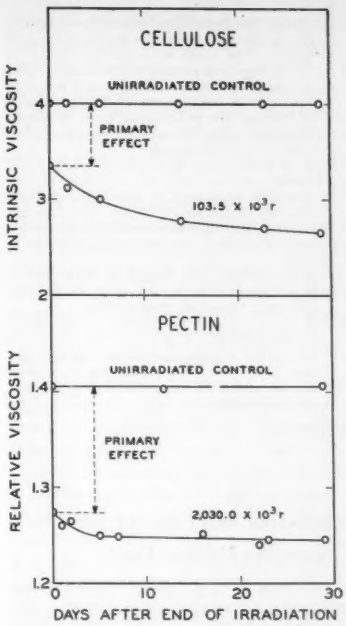

Fig. 1. Changes in solution viscosities of cellulose and pectin irradiated and stored in the solid (dry) state at room temperature. The primary effect is the change induced in the viscosity of the original sample by gamma rays and ascertained as soon after the end of irradiation as practicable (within 5 hr). The aftereffect is the change that occurs after the first viscosity measurement on irradiated samples.

The phenomenon reported here is unique in that the aftereffect occurred in solid (dry) samples, whereas those previously reported (*1*–*4*) involved substances irradiated in the presence of water. In fact, cellulose and pectin samples of various moisture contents were investigated and the aftereffect was observed only in the afore-mentioned samples which were of the lowest moisture levels studied.

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Armed Forces and has been assigned number 657 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or endorsement of the Department of Defense. The technical assistance of Marcia Davidson, Miles Connor, and Leon Lind is gratefully acknowledged.

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25 July 1956

Radiostrontium Fallout from Continuing Nuclear Tests

In spite of widespread comment on the problem of the fallout of radiostrontium from testing thermonuclear weapons, confusion persists in the public mind and perhaps among many of the readers of *Science* as well regarding the relationship of Sr^{90} accumulation on the ground to such factors as assumed mean storage time in the stratosphere and the rate of testing of thermonuclear weapons. Libby's recently published report on the AEC's studies of the Sr^{90} problem (*1*) was not addressed to the effects of continuing weapons tests. Yet his conclusions have recently been quoted in the press as if they were valid if tests continue provided only that test rates remain unchanged.

Libby's analysis considered essentially the question whether nuclear weapons tests to date may have committed us already to an intolerable accumulation of Sr^{90}. Happily they have not. Speaking to that point, the meteorologists on the National Academy of Sciences study of the biological effects of atomic radiation stated, "At present, the amount of Sr^{90} in the stratosphere from nuclear weapon tests is far too small to approach maximum permissible concentration even if it all were to be deposited now. However, if the testing programs of the several countries producing thermonuclear weapons were to intensify, stratospheric storage time may become a critical item in terms of hazard to mankind. For this reason, a continuing program to investigate this phenomenon is needed, including actual measurements of the radioactivity in the stratosphere and improved and more representative methods of observing fallout" (*2*, p. 60).

The consequences of continued tests can be discussed in terms of a simple mathematical model which is generally accepted by Libby and others in this country as well as in England (*3*). Assume that Sr^{90} is introduced at a constant rate n into the stratosphere, where it is immediately mixed uniformly over the entire globe. According to British data, mixing is evidently reasonably rapid (*3*, p. 11). Assume further that fallout occurs at a rate $R = kQ$, where Q is the instantaneous stratospheric storage and k is the reciprocal of the mean stratospheric storage time.

Accumulated radiostrontium on the ground, M, can then be shown to be

$$M = \frac{n}{\lambda}\left[\frac{k}{k+\lambda} + \frac{\lambda}{k+\lambda}\, e^{-(k+\lambda)t} - e^{-\lambda t}\right] \quad (1)$$

where λ is the radioactive decay constant of radiostrontium. If the constants are expressed in years and the rate of testing is expressed in terms of millicuries of Sr^{90} per square mile of the earth's surface introduced per year into the stratosphere, M is given in terms of millicuries of Sr^{90} per square mile at t years. When $t = \infty$

$$M_{max.} = \frac{nk}{\lambda(k+\lambda)} \quad (2)$$

and the maximum accumulation of fallout is seen to be proportional to the test rate.

Using Libby's best estimate for the mean stratospheric storage time of 10 years and a conservative estimate of the test rate corresponding to the introduction of 2.5 mc/mi² yr, per year as a reasonable value for n, the maximum accumulation of radiostrontium would be about 80 mc/mi². Libby, *considering only the Sr^{90} produced up to 1955*, predicted maximum fallout of less than one-tenth this amount. The two figures should not be confused.

It is not yet known what fraction of the total radiostrontium produced from a thermonuclear weapon reaches the stratosphere and becomes involved in the fallout process discussed here. For this reason, we do not know how to interpret available data on test rates and accumulation of Sr^{90}—for example, whether little has reached the stratosphere and has subsequently fallen out again relatively quickly or whether much has entered the stratosphere but has been held back by a long storage time. It cannot be said with much confidence, therefore, what rate of weapons testing would result in a given accumulation of Sr^{90}.

Assuming a 10-year storage time and a continuing test rate about twice that mentioned in a previous paragraph (corresponding to estimates made by Stewart, Crooks, and Fisher in the United Kingdom), the Sr^{90} accumulated on the ground after about 35 years would be 80 mc/mi². This would correspond to about 0.14 MPC (maximum permissible concentration) unit in the soil. According to Libby (*4*), Sr^{90} levels in soils are converted to levels in bones of young children at about 70 percent efficiency. This reduces the figure for levels in young children after 35 years of continuous tests to about one-tenth the permissible levels as established for *occupational* exposures. The concentration would not fall much below 0.07 MPC unit even if storage time were found to be 20 years instead of 10. Recently committees of the National Academy of Sciences (*2*, p. 39) and the British Medical Research Council (*5*, par. 281) have expressed their belief that only 0.1 MPC unit or less should be permitted for the population at large. In fact, the British report stated (*5*, par. 360) "So far as radioactive fallout may affect the individual, we believe that immediate consideration would be required if the concentration of radioactive strontium in bone showed signs of rising greatly beyond that corresponding to one-hundredth of the maximum permissible occupational concentration." The rate of introduction of Sr^{90} into the stratosphere assumed here is close to that estimated by Libby for the past three years. On the assumptions made here, therefore, a long-term test program could conceivably reach or exceed the levels of Sr^{90} considered safe for the whole population.

There is little reason to hope that what may be learned about storage time, k, will change this situation much. We must hope that new information may allow us to increase the maximum permissible concentration of radiostrontium in the bodies of the people of the world, that means may be found to decrease the input of Sr^{90} to the stratosphere from tests, or, preferably, that a new attitude among the people of the world will permit us to lower the test rate, n.

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10 September 1956

Book Reviews

Atoms and People. Ralph E. Lapp. Harper, New York, 1956. 304 pp. $4.

Facing the Atomic Future. E. W. Titterton. Macmillan, London; St. Martin's Press, New York, 1956. 379 pp. Illus. + plates. $5.

These two timely books deal with the history of the development of nuclear energy and, more important, with its social, moral, and political implications. Both authors are nuclear scientists and, as men of integrity and good will, are profoundly impressed by the fact that nuclear power for war is a stark reality, while practical and economic nuclear power for peaceful uses is still in the future.

Lapp's book provides the vivid reading of a novel and is as difficult to lay down as a novel would be. Step by step, Lapp traces the story of the development of the theory of the chain reaction, the first pile, the first bomb, and finally the complete family of nuclear weapons. Having served in the Pentagon as an adviser for the Defense Department, Lapp writes intimately, and often most critically, of political maneuverings in the unfolding story of nuclear energy.

Titterton's volume is less easy to read but covers in a scholarly and more detailed way the same story. As an Australian, Titterton discusses at every step the specific implications for his own country. Tables, formulas and graphs abound in the book, and there are a number of pertinent photographic illustrations.

Both authors devote space to thermonuclear reactions, not only as agents of destruction, but as possible sources of industrial power. Both men are impressed with the urgent need for the development of an adequate civil defense. Both discuss in detail the possibilities and limitations of diverse nuclear machines as sources of industrial power, stressing the hazards, the economic feasibility, and the difficulties as well as the hopes along these lines. Both books are concerned with the increasingly critical problem of the safe disposal of atomic wastes.

Both authors end their books with careful, thought-provoking discussions of the social and ethical problems raised by the availability of nuclear energy. A dilemma has in fact been created, on the one hand by man's increasing faith in his capacity to expand his technologic and scientific horizons, and on the other by his mounting skepticism in regard to his ability to solve the resulting social problems. It would be indeed tragically ironic if the same thermonuclear reactions which, by taking place in the sun, make possible our very existence on this earth should, through our own social bungling, lead to our extinction. Scientists in all fields will do well to give thoughtful consideration to both of these books.

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Transport and Accumulation in Biological Systems. E. J. Harris. Academic Press, New York; Butterworths, London, 1956. 291 pp. Illus.+plates. $7.80.

The increasing emphasis currently being given to solute transfer studies in biological systems is doubtless the result of a recognition that such processes are as basic to our understanding of cell function as are those biochemical reactions more directly concerned with metabolism. For this reason, this book should be especially welcomed by workers who desire a comprehensive survey of the rather large number of papers on ion and molecule transport that have appeared in recent years. The scope of this book is perhaps best given by mentioning the number of pages devoted to particular aspects of the problem: membrane structure and penetration (14), the distribution and movements of water (41), the distribution of ions (31), blood cells (47), amphibian skins (15), muscle (15), mitochondria (4), ion movement in various tissues (32), nonmyelinated nerve (26), medullated nerve (26), plant cells and yeast (12).

A useful introduction to the ways by which both molecules and ions may be expected to move in membranes is given in a rather thorough treatment of the physical chemistry of osmotic processes and ion diffusion. The following chapters consider transport, both passive and active, in a variety of cells. Emphasis is on recent publications that deal with measured unidirectional tracer fluxes and also on red blood cell studies, a field of special interest to the author; this does not necessarily mean that our understanding of active transport in these cells is better than it is for others, rather the reverse because the additional complication of an enormously rapid anion transfer, as compared with cation transfer rates, surely makes the analysis of the membrane more complex.

The discussion of many of the points concerned with the experimental data is generally quite critical, and the author refrains from presenting a particular point of view; indeed the subject matter is hardly amenable to a comprehensive or general treatment, for present-day characterization of the processes that drive ions against electrochemical gradients can be described only as mysterious. On the other hand, tremendous progress has been made in ascertaining the relationships that must exist between ion movements and membrane potential, as the elegant work of the Cambridge physiologists shows. Emphasis has been properly given by the author to the fact that recent experimental evidence can be interpreted as showing that tracers do not measure true fluxes in the presence of a net flux across the membrane; it may be questioned whether this effect can exist for water movement across the membrane, as Harris suggests, but this is one of the few points where one might take issue with the treatment in a book that I warmly recommend.

L. J. MULLINS
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Introduction to Electronic Analogue Computers. C. A. A. Wass. McGraw-Hill, New York; Pergamon, London, 1955. x + 237 pp. Illus. $6.50.

The author of this book has done an excellent job of presenting the basic principles of analog computation. It is recommended for the reader who is interested in a general survey of electronic analog computation methods and techniques as well as for the beginner entering the computer field. The book sticks to basic principles rather than going into the details required by those who have a serious interest in designing and building computers.

The subject matter is essentially limited to electronic analog computers; other types, such as network analyzers, mechanical devices, and electromechan-

ical equipment are only briefly mentioned. Analog and digital computers are compared, and their relative merits for different applications are discussed. Errors in computation owing to limited gain, grid current, drift and nonideal components in operational amplifiers are covered in some detail. The use of the analog computer as a simulator is emphasized, and examples are given of its application in many fields, including aircraft dynamics, ballistics, electron motion, and spring suspension systems. The description of British analog computer equipment is of interest to Americans, who for the most part are unfamiliar with this equipment. The terminology and symbolism are British, which differ considerably from American usage.

Readers interested in more advanced treatments of the subject of analog computation should supplement reading of this book by reference to such textbooks as *Electronic Analog Computers* by Korn and Korn, or *Analog Computer Techniques* by Johnson. These books use terminology and symbolism current in the United States, describe American-made equipment, and go into much more detail concerning design and application.

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Gmelins Handbuch der Anorganischen Chemie. System No. 28. *Calcium*. pt. B, sec. 1. Technology. Verlag Chemie, Weinheim/Bergstrasse, ed. 8, 1955. 264 pp. Illus. DM 147.

This book is another volume in the highly respected Gmelin series of reference handbooks in inorganic chemistry and is concerned with the technology of calcium and compounds of calcium. The many desirable characteristics of previous volumes are continued in this one. It is stated that the literature through 1949 is completely covered, but a number of references as late as 1953 are found in the body of the text. The German text is simple and easily readable. A detailed table of contents is furnished at the beginning of the volume. At the beginning of each section (corresponding generally to a given compound) is given a series of general references on that particular substance. Insofar as I can judge, the volume attains something near completeness in its coverage and is well prepared. It should be valuable to any worker in this field and to any chemistry reference library.

Harry H. Sisler
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Radiation Dosimetry. Gerald J. Hine and Gordon L. Brownell, Eds. Academic Press, New York, 1956. 932 pp. Illus. $22.

Having set up a system of units, it is in general a simple matter for one to measure the quantity or rate of flow of solids, liquids or gases. This is not the situation in the measurement of radiation, an intangible entity which early in its history was believed by some to represent a fourth state of matter. The flux of radiation penetrates the molecular structure of matter, causing excitation and ionization, and at higher energies also interacts with the nuclei, altering the fundamental identity of the component atoms. The absorption of energy and the effectiveness in producing chemical and biological change is highly dependent on the nature and kinetic energy of the incident radiation and on the chemical composition and state of the absorbing medium. Hence, it is not surprising that an extensive treatise can be written devoted to a single facet of radiation research. Indeed, this comprehensive work on radiation dosage will be welcomed, not only by practicing radiologists, but also by the host of investigators concerned with radiation effects in nonliving structures such as plastics and metals exposed to the dense flux of radiation produced by nuclear reactors.

The present volume edited by G. J. Hine and G. L. Brownell is a result of the collaborative efforts of 22 contributors who are well known in their respective fields of specialization. The book is organized into three main sections dealing with the fundamental principles of dosimetry, radiation detectors, and the dosimetry of radiation fields. The first section is devoted to a thorough discussion of radiation units, the interaction of electromagnetic and corpuscular particles with matter, and the biological effects of radiation on normal and malignant tissues. The treatment centers on the derivation of basic relationships and is supplemented by numerous tables and charts of experimental data.

The book makes no reference to the more recently discovered fundamental particles and ignores the existence of well-established particles such as the μ- and the π-mesons which are produced in copious number by the larger accelerators. Likewise, the treatment of heavy charged particles stops with the alpha particle, and only brief mention is made of stripped nuclei, such as carbon, or the fission fragments, without adequate discussion of the biological effectiveness of the energy liberated along the trajectory of these massive projectiles.

About 400 pages are devoted to a close scrunity of radiation detectors and their calibration. This section of the book not only contains excellent descriptions of the more familiar methods of charged particle instrumentation but also has large chapters devoted to photographic techniques, scintillation counters, chemical radiation indicators and dosimetry by microcalorimetric methods. The several chapters are extensively documented, but the references are chiefly to American and English sources. With a wealth of declassified material to choose from, this tendency to accentuate the American and British work is understandable, but in doing so many important European contributions have been neglected. Thus, the chapter on calorimetry makes no mention of the extensive contributions of the Polish school of investigators on the use of microcalorimetric techniques in the measurement of the heat liberated by small radioactive sources. Neither does it refer to an excellent summary of this work available in the English textbook *Microcalorimetry* by W. Swietoslawski.

The third section is devoted to the production of radiation by accelerators and teleisotope sources. It is written largely from the viewpoint of the practicing radiologist. It is concerned with the evaluation of depth dose arising from the impingement of external beams of radiation and tissue dosages arising from internally administered radioisotopes. An outstanding feature of these chapters is the lucid exposition of the methods for computing the dosage to specific areas under treatment, providing the reader with sample calculations and additional references to the medical literature. Radiation physicists will also be grateful for the inclusion of an extensive table giving the weight and composition of the organs of a standard man, and for recipes for simulating the chemical composition of normal tissue.

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Enzymes: Units of Biological Structure and Function. Henry Ford Hospital International Symposium. Oliver H. Gaebler, Ed. Academic Press, New York, 1956. 624 pp. Illus. $12.

The fourth symposium of the Henry Ford Hospital was held in Detroit, 1–3 Nov. 1955. The symposium volume contains 27 formal papers with discussions and two special lectures [see *Science* **123**, 149 (1956) for a detailed report of the meeting]. The symposium was not concerned primarily with the classical interest of enzymology, the properties of isolated biocatalysts, but rather considered the enzyme in relation to the function

and structure of the organism. The various topics of discussion were mechanisms of enzyme formation, including enzyme induction, cellular differentiation, and the role of nucleic acids in enzyme synthesis; the relationship of genes to enzymes; enzymes and cell structure; the enzymatic basis of some physiological functions, including muscular work, excretion, vision, and bioluminescence; the mechanisms of energy supply to the cell; and the natural and artificial regulation of enzyme activity in the cell.

The organizers of the symposium selected a panel of exceptional competence, so the published papers are authoritative and of the highest quality. Some of the papers contain new material not published elsewhere and will be of interest even to specialists. The symposium as a whole covers such a broad field that it should be of great value to both teachers and graduate students in the biological sciences as a guide to current interests and future trends in research on enzymes. There are few biologists whose viewpoint would not be broadened by a careful reading of this volume.

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Books Reviewed in The Scientific Monthly, November

Report of the Special Committee on the Federal Loyalty-Security Program of the Association of the Bar of the City of New York (Dodd, Mead). Reviewed by Z. Chafee, Jr.

Illustrations of the Huttonian Theory of the Earth, J. Playfair (facsimile reprint with an introduction by G. W. White, University of Illinois Press). Reviewed by E. W. Berry.

Plane Trigonometry, E. R. Heineman (McGraw-Hill). Reviewed by J. R. Mayor.

Man, Culture, and Society. H. L. Shapiro, Ed. (Oxford University Press). Reviewed by R. F. Herzfeld.

Soranus' Gynecology, Translated with an introduction by O. Temkin with the assistance of N. J. Eastman, L. Edelstein, A. F. Guttmacher (Johns Hopkins Press). Reviewed by J. B. deC. M. Saunders.

The Theory of Sound, vols. 1 and 2, J. W. Strutt and B. Rayleigh (Dover).

Demographic Yearbook 1955 (Statistical Office of the United Nations, New York).

New Worlds of Modern Science, L. Engel, Ed. (Dell).

New Books

Handbuch der Physik. vol. XXXVI, *Atome II.* S. Flugge, Ed. Springer, Berlin, 1956. 424 pp. DM. 88.

Antarctica in the International Geophysical Year. Based on a symposium on the Antarctic. Geophysical Monogr. No. 1. American Geophysical Union, Washington, 1956. 133 pp.

Information Theory. Third London symposium, 1955. Colin Cherry, Ed. Academic Press, New York; Butterworths, London, 1956. 401 pp. $11.50.

Exploration for Nuclear Raw Materials. Robert D. Nininger. Van Nostrand, Princeton, 1956. 293 pp. $7.50.

Neurotic Interaction in Marriage. Victor W. Eisenstein, Ed. Basic Books, New York, 1956. 352 pp. $5.50.

Population Theory and Policy. Selected readings. Joseph J. Spengler and Otis D. Duncan. Free Press, Glencoe, Ill., 1956. 522 pp. $7.50.

Engineering as a Career. Ralph J. Smith. McGraw-Hill, New York, 1956. 365 pp. $4.75.

Currents, Fields, and Particles. Francis Bitter. Technology Press, Cambridge, Mass.; Wiley, New York; Chapman & Hall, London, 1956. 599 pp. $8.50.

An Introduction to Cell and Tissue Culture. By the Staff of the Tissue Culture Course, Cooperstown, N.Y., 1949–1953. Burgess, Minneapolis 15, Minn., 1955. 123 pp. $4.

Procedure in Taxonomy. Including a reprint in translation of the *Regles Internationales de la Nomenclature Zoologique.* With titles and notes on the opinions rendered to the present date (1907 to 1956). Edward T. Schenk and John H. McMasters, A. Myra Keen and Simeon William Muller, Eds. Stanford University Press, Stanford, Calif., ed. 3, 1956. $3.50.

Living Magic. The realities underlying the psychical practices and beliefs of Australian aborigines. Ronald Rose. Rand McNally, New York, 1956. $3.75.

Steric Effects in Organic Chemistry. Melvin S. Newman. Wiley, New York; Chapman & Hall, London, 1956. 710 pp. $12.50.

Robert Hooke. Margaret 'Espinasse. University of California Press, Berkeley, 1956. 192 pp. $3.75.

American Social Patterns. Studies of race relations, popular heroes, voting, union democracy, and government bureaucracy. William Petersen, Ed. Doubleday, Garden City, N.Y., 1956. 263 pp. $0.95.

Laboratory Experiments in General Chemistry. G. Brooks King and William E. Caldwell. American Book, New York, 1956. 324 pp. $3.25.

Chromosomes, Sex-Cells and Evolution in a Mammal. Based mainly on studies of the reproductive glands of the gerbil and a new list of chromosome numbers of mammals. Phillip V. Tobias. Percy Lund, Humphries, London, 1956. 420 pp. 60s.

Dictionary of Photography. Reference book for amateur and professional photographers. A. L. M. Sowerby, Ed. Iliffe, London; Philosophical Library, ed. 18, New York, 1956. 719 pp. $10.

Human Generation, Conclusions of Burdach, Dollinger and von Baer. Arthur W. Meyer. Stanford University Press, Stanford, Calif.; Geoffrey Cumberlege, Oxford University Press, London, 1956. 143 pp. $3.50.

Handbook of Scientific and Technical Awards in the United States and Canada. Margaret A. Firth, Ed. Special Libraries Assoc., New York 3, 1956. 491 pp. $10.

Handbook of Basic Circuits. TV—AM—FM. Matthew Mandl. Macmillan, New York, 1956. 365 pp. $7.50.

Fundamentals of Physics and Applications. Howard O. Sterns. Macmillan, New York, ed. 2, 1956. 384 pp. $6.50.

Dictionary of Poisons. Ibert Mellan and Eleanor Mellan. Philosophical Library, New York, 1956. 150 pp. $4.75.

The Biological Basis of Human Freedom. Theodosius Dobzhansky. Columbia University Press, New York, 1956. 139 pp. $2.95.

Creative Communication. Edwin Laird Cady. Reinhold, New York; Chapman & Hall, London, 1956. 158 pp.

Engineering Inspection, Measurement and Testing. H. C. Town and R. Colebourne. Philosophical Library, New York, 1956. 192 pp. $8.75.

Induction Heating Practice. A handbook on the high-frequency induction process for all concerned with engineering production. D. Warburton-Brown. Philosophical Library, New York, 1956. 192 pp. $10.

Social Characteristics of Urban and Rural Communities, 1950. Otis D. Duncan and Albert J. Reiss, Jr. *Census Monograph Series.* Wiley, New York; Chapman & Hall, London, 1956. 421 pp. $6.50.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

A Revision of the Genus Megarthroglossus Jordan and Rothschild, 1915 (Siphonaptera: Hystrichopsyllidae). University of California Publ. in Entomology, vol. 11, No. 3. Eustorgio Mendez. 34 pp. $0.85. *A Revisional Study of the Bees of the Genus Perdita F. Smith, with Special Reference to the Fauna of the Pacific Coast (Hymenoptera, Apoidea)* pt. II. Publ. in Entomology, vol. 11, No. 5. P. H. Timberlake. 104 pp. $2. *The Armored Scale Insects of California.* Bull. of the California Insect Survey, vol. 5. Howard L. McKenzie. 209 pp. Cloth, $6; paper, $4.50. University of California Press, Berkeley, 1956.

Statistical Tables for Use with Binomial Samples—Contingency Tests, Confidence Limits, and Sample Size Estimates. Donald Mainland, Lee Herrera, Marion I. Sutcliffe. New York University College of Medicine, New York 16, 1956. 83 pp. $2.

Permafrost and Some Characteristics of Bogs and Vegetation of Northern Quebec. Bull. du Service de Biogeographie No. 14. John E. Potzger and Albert Courtemanche. Service de Biogeographie, Université de Montreal, Montreal, Canada, 1955. 6 pp.

Meliaceae, Anacardiaceae, Tamericaceae, Cornaceae, Oleaceae, Bignoniaceae of Nevada. Contributions toward a Flora of Nevada No. 40. Elbert L. Little, Jr. U.S. Department of Agriculture, Plant Industry Station, Beltsville, Md., 1956. 81 pp.

Meetings and Societies

Physiological Congress

Notwithstanding a spectacular storm in the English Channel that caused cancellation of all sailings on the day preceding the congress and delayed a number of British and American scientists, the 20th International Physiological Congress opened as scheduled on 30 July at Brussels, Belgium. The following 4 days were devoted mainly to papers of physiological interest, with the fifth and last day oriented more specifically to pharmacology. Credit for the smooth functioning of the scientific sessions and the full and enjoyable round of free civic entertainments must be accorded chiefly to the renowned president of the congress, C. Heymans (Ghent, Belgium) and his able secretary, J. Reuse (Brussels, Belgium), as well as to the members of the organizing committee.

The size of the congress can be judged from the statistics: more than 2600 members from 43 different countries presented 967 communications in 74 separate sessions. In addition, 55 papers were given in 13 symposia, two special meetings were held, 31 films were shown in three sessions, and 29 exhibits were demonstrated. Although communications could be given in any language of choice, the language most frequently employed was English, followed by French and to a much lesser extent by German, and on occasion a translator was used.

Behind the cold statistics of the congress lies the story of successful cooperation among scientists from countries the world over, who were welded into a single concrete union for the brief space of a week. The advantages of such an international congress were perhaps best expressed by C. H. Best (Toronto, Canada), president of the International Union of Physiological Sciences, in his speech at the opening ceremony of the congress, which was attended by gracious Queen Elizabeth of Belgium: "One always learns of important advances which difficulties of language, or lack of time and energy to read the literature, have previously denied us. I have met for the first time many of those who have become my close friends and have gained some of my most interesting pupils through attendance at these International Physiological Congresses. Our vital concern for the advance of our subject and the intense and friendly interest which this must produce in colleagues throughout the world is the motivating force for all the activities of your Council. . . ."

The congress was distinguished by the interest shown in the higher functions of the nervous system and in behavioral patterns, which were treated very thoroughly, both from the physiological and from the pharmacological standpoint. Morning sessions were occupied with personal communications and films, and afternoon sessions were devoted to symposia. Because adequate coverage of nearly 1000 private communications is impossible without some injustice in picking a few papers for review out of a large number of high merit, principal attention has been paid to reporting symposia. In this way the direction of emphasis set by the program committee of the congress is more faithfully preserved, while the opportunity is reduced for the reviewer to yield to an unconscious tendency to report more fully on papers within his own sphere of interest.

On the first day of scientific sessions, three symposia were held simultaneously. One of these, under the chairmanship of Lord Adrian (Cambridge, England), dealt with neuronic inhibition and excitation. The first speaker, P. Fatt (London, England), described recent work on the membrane potential of the neuron and concluded that changes of the excitatory and inhibitory synaptic responses are due to two distinct changes in permeability of neuron membranes. W. Feldberg (London, England), speaking from the pharmacological standpoint, described experiments concerning the injection of drugs into the third ventricle and found changes in excitation resembling anesthesia, grand mal, and certain types of psychiatric disturbances. A. Fessard (Paris, France) gave an authoritative survey of the data available from electric records of single neurons, pointing out the diversity in the types of neurons in the central nervous system and the existence of many gaps in our present knowledge.

A symposium on the general physiology of cardiac muscle was opened by S. Weidmann (Berne, Switzerland), who gave a penetrating survey of the electrophysiology of single heart muscle fibers. C. M. Brooks (New York, U. S. A.) presented the theory that fibrillation originates from influences that exaggerate dissimilarities of heart cells or create localized states of hyperexcitability. A. Szent-Györgyi (Woods Hole, U. S. A.), in his colorful lecture on contraction in the heart muscle fiber, advanced the hypothesis that the water molecules in heart muscle are arranged in the same lattice structure as in ice.

In a symposium on the physiology of acid secretion by the stomach, E. J. Conway (Dublin, Eire) reviewed the mechanism of the electron transport involved in acid secretion, and B. Uvnäs (Stockholm, Sweden) reviewed the nervous and humoral control of this secretion. Uvnäs agreed with the accepted view that hydrochloric acid secretion is stimulated by gastrin via a route lying outside the stomach and presented new evidence that release of gastrin by the antrum is inhibited by the hydrochloric acid within the stomach, if this acid reaches the antrum. Thus if the intact antrum is protected from the acid content of the stomach, as may occur in surgery on human beings, a dangerous hypersecretion of gastric juice may result. Clinical experience suggests that the mucosa of the duodenal bulb may also secrete gastrin, explaining cases of persistent hypersecretion following an operation of gastric resection that leaves the duodenal bulb intact. In the same symposium, R. A. Gregory (Liverpool, England) reported that dietary fat may liberate a duodenal hormone that inhibits gastric secretion, in addition to its well-known reduction of gastric motility. The last speaker, K. M. Bykov (Leningrad, U.S.S.R.), reported that glands of the lesser curvature of the stomach are under the influence of the vagus, while glands of the greater curvature are innervated mainly by the sympathetic nerve, and through these two nerves the cerebral cortex exerts a powerful stimulating effect on gastric secretory cells. Observations of secretion in a dog with two pouches formed on the lesser and greater curvatures showed that gastric secretion is excited by the vagus when the dog is eating bread but by the sympathetic nerve when it is drinking milk. Although denervation of the pouches reduced secretion, administration of carbocholine and adrenaline restored normal secretion to food stimuli.

On the next afternoon, four symposia were held simultaneously. In the symposium on the initiation of the sensory discharge, the chairman, H. Schaefer (Heidelberg, Germany), summarized the problem apparent from the three

papers presented by asking how a few (2 to 10) quanta of light could arouse a process powerful enough to depolarize a membrane that is both far away and large in surface. The answer given by Schaefer was that a complicated multiplier process, biochemical in nature, may be involved in the primary process of vision; a similar explanation may also hold for mechanical receptors, for which the chemical structure of the membrane will be the dominant factor. Schaefer thought that purely electrophysiological methods for investigating cellular excitation were nearing the limit of their usefulness and biochemical methods were now required to uncover the root of the problem.

The first speaker of a symposium on the physiology of water and food intake, B. Andersson (Stockholm, Sweden), showed a film demonstrating the effect of stimulating the thirst center in the hypothalamus of the goat by means of electric signals supplied to implanted electrodes. After a time lapse as short as 5 seconds, the goat began to drink from a nearby tank of water and continued drinking until 2 or 3 seconds after the end of electric stimulation; thus a goat could be induced to drink up to 40 percent of its own body weight of water, which constitutes a toxic dose. Destruction of the thirst center permanently reduced or temporarily eliminated water intake, suggesting that the thirst center is an essential structure. J. R. Brobeck (Philadelphia, U.S.A.) presented evidence for the view that the medial hypothalamus is concerned with "satiety" while the lateral portions are responsible for "appetite." Thus medial lesions in all species studied, including man, lead to obesity, while destruction of the lateral regions in experimental animals produces fasting.

At the suggestion of the Academy of Sciences of Moscow, a special symposium on the structure and function of the brain was held, in which six workers from the U.S.S.R. participated. What apparently constituted the official standpoint of physiologists and pharmacologists from the U.S.S.R. was later obtained during a conversation with S. V. Anichkov (Leningrad, U.S.S.R.). This outlook is based on Pavlov's view that the nerve system is the controlling factor for all functions of the organism. According to this view, the organism should be studied as a whole and under conditions as close as possible to normal conditions of life rather than through resection or isolation of tissues or organs, though such latter studies are not necessarily contraindicated. Humoral factors are of interest, but are connected with nerve systems and cannot rightly be separated one from the other.

Another special symposium was held on the afternoon of 1 Aug. on the physiological effects of gravitational stress, a subject of particular interest to aeromedical research workers. The meeting had a truly cosmopolitan flavor, with ten speakers representing eight different countries. The reports included a paper by R. H. Goetz (Cape Town, South Africa) on the blood circulation of the giraffe, an animal that must pump blood to such vertical heights that it is to students of circulation what the whale is to Paul Dudley White.

The next afternoon and evening were set aside for sightseeing excursions to Ostend, Ghent, or Bruges aboard two trains hired specially for congress members. During daytime, conducted tours enabled members to see places of historic interest, visit museums and art galleries, indulge their hobby of photography, or shop for delicate Belgian lace. An evening spent in Ghent was especially memorable, for the narrow cobbled streets, the gilded municipal buildings, and the quaint canals were all floodlit for the occasion.

On the afternoon of 3 Aug., a symposium was held on the general physiology of striated and smooth muscle. The first speaker, A. F. Huxley (Cambridge, England), presented substantial evidence for the novel view that when a muscle fiber stretches or contracts the filaments of actin and myosin remain essentially constant in length but slip past one another in each zone where they overlap. The rival theory, currently widely accepted, holds that contraction is produced by the progressive folding or coiling of filaments. B. Katz (London, England) presented evidence for the hypothesis that the end-plate potential is due to a nonspecific increase in ionic permeability in the junctional region, in which the prevalent ions are simultaneously involved. Rounding out the session, E. Bülbring (Oxford, England) discussed microelectrode recordings of the responses of smooth muscle.

In a symposium on hypothermia, E. Neil (London, England) analyzed in detail the dangers of both respiratory and metabolic acidosis. To insure full recovery of *all* patients after circulatory arrest during hypothermia (26°C), a period of arrest no longer than 4 minutes was recommended. M. Schneider (Köln, Germany) stated that hypothermia leads to irreversible changes only if ice forms in the tissues, or if asphyxia occurs through respiratory or cardiac failure. According to Schneider, many of the adverse changes seen in hypothermia are due to lack of oxygen and could be avoided if oxygen consumption were maintained. The last speaker, J. Giaja (Belgrade, Yugoslavia), described work by Vidović on the effect of hypothermia on pregnancy in rats. Exposure to hypothermia early in pregnancy produced no visible ill effects, while at later stages the effects became progressively more adverse as term was approached.

Starting at a time when the other symposia were just concluding, a special symposium on quantitative drug antagonism turned into a marathon of endurance in the crowded lecture theater, with progressive attrition of the audience as the hands of the clock crept inexorably toward 7 o'clock. The first speaker, S. Loewe (Salt Lake City, U.S.A.), discussed further advances in the use of his isobolograms for depicting quantitative drug antagonism. J. H. Gaddum (Edinburgh, Scotland) stressed the possibility that a drug might produce its maximum effect when only a small percentage of receptor sites are saturated, a possibility that would upset some current theories of drug action by contradicting one of their basic assumptions. The next speaker, H. O. Schild (London, England), in general supported this point of view. E. J. Ariens (Nijmegen, the Netherlands) outlined different theories for the action of drug and antagonist on receptor to produce an effect and applied his theories to experimental data on cholinesterase inhibition. M. Nickerson (Winnipeg, Canada) discussed drug antagonism from the standpoint that receptor response is proportional to the number of sites occupied, with maximum response produced only when all receptor sites are occupied. In the last paper, M. Rocha e Silva (São Paulo, Brazil) presented evidence that the diffusion process is not responsible for the delay in recovery from the effects of drug antagonists. The symposium served to demonstrate a lack of universal agreement regarding the basic mechanism of drug antagonism.

In one of the two sessions held in the afternoon of the "Pharmacologists' Day," B. A. Houssay (Buenos Aires, Argentina) presided over a symposium concerning pharmacological actions on the hypothalamus and pituitary gland. In his report on the control of adrenocorticotrophic (ACTH) secretion by the pituitary gland, C. Fortier (Houston, U.S.A.) stressed that ACTH secretion in response to stress is possible in the absence of the adrenals and that the central nervous system is involved in many cases of ACTH discharge into the circulation. Evidence is accumulating that the action of the hypothalamus on the pars distalis of the pituitary is not conveyed by nerve fibers, but that some chemical agent is liberated in the hypothalamus and is conveyed to the pituitary by the portal vein system of the stalk. According to Fortier, it is not clear whether the site of the inhibitory action of corticoids on ACTH release is at the hypothalamic or at the pituitary level. G. W. Harris (London, England) concluded that thyroid func-

tion is governed by the level of TSH (thyroid-stimulating hormone) secretion by the anterior pituitary, which in its turn is regulated humorally by the hypothalamus via the hypophyseal portal system. The hypothalamic humoral factor apparently produces simultaneous release of both ACTH and TSH, while thyroxin acts on the hypothalamus as well as on the pituitary. The last speaker, S. E. de Jongh (Leiden, the Netherlands), discussed the regulation of gonadotrophin secretion that leads to ovulation. Stimuli that produce a release of gonadotrophic hormone may follow a nervous pathway that ends in the median eminence of the hypothalamus, releasing a humoral factor that is conducted to the pars distalis via the hypophyseal portal system. This view explains why certain substances that act either on the hypothalamus or on the pituitary can initiate or inhibit ovulation.

C. F. Schmidt (Philadelphia, U.S.A.), chairman of a symposium on psychopharmacology that concluded the formal meetings, summarized his impressions of the symposium in three points. First, there was general agreement that the reticular formation of the midbrain was closely linked with mental abnormalities and with the site of action of tranquilizing or psychoses-producing drugs; further study of this area of the brain would appear to hold particular promise at this time. Second, the symposium served to discredit some attractive biochemical possibilities, such as that serotonin may be a prominent factor in ataraxia or hallucinations. Third, the correlation between chemical structure and effects of psychoses-producing drugs now appears less definitive, and there is at present little prospect of explaining drug actions or spontaneous mental abnormalities in terms of a common chemical grouping.

Among the most entertaining features of the congress were the film sessions, in which high standards of competency and ingenuity were displayed; unfortunately space permits mention of only a few of many memorable films. O. G. Edholm *et al.* (London, England) answered the question on what to do in a shipwreck that leaves one clinging to a piece of driftwood in cold water miles from shore: the best bet is to hang on quietly, perhaps giving an occasional kick or two. According to Edholm, the real killer in cold water is loss of body temperature, aided and abetted by exhaustion. A thin person loses body temperature fast in cold water if he remains inactive, but even faster if he swims about, because the heat generated passes into the water and is lost. A fat person on the other hand is insulated by his thick layer of subcutaneous fat and therefore loses heat much more slowly if he remains still, or not at all if he swims about; yet, because of the danger of exhaustion, he also should remain relatively inactive. In a film entitled "Physiology on Mount Everest," L. G. C. Pugh *et al.* (London, England) stated that partly owing to the physiological advances made in the successful expedition on Mount Everest in 1953, within three succeeding years all the six highest peaks in the world have now been climbed. One of the advances has been the realization that acclimatization for 3 to 4 weeks at altitudes up to 18,000 feet is necessary to shake off infectious diseases brought out in this environment as well as to obtain physiological adjustment. A fluid intake as high as 3 to 4 liters per day is required, and because of loss of appetite most of the calories should be given in liquid form. The best oxygen device to date has been a lightweight (aluminum) open-circuit breathing apparatus, while the special multilayer clothing and the camping equipment developed to withstand the bitter cold and high winds have fulfilled essential requirements for success. In part of their film regarding physiological problems on a polar expedition, H. E. Lewis and J. P. Masterton (London, England) explained that the Eskimo's igloo is a most efficient shelter because of the wonderful insulation provided by myriads of tiny pockets of air trapped within the frozen snow.

At the closing dinner, the president of the congress announced that the next International Physiological Congress is scheduled to be held in 1959 at Buenos Aires, Argentina, under the distinguished chairmanship of B. A. Houssay. At my table, scientists from widely separated lands joined in the toast "to the banishment of all frontier-barriers in science." A universal feeling of good will was also reflected by the official speakers, who expressed their satisfaction with the success of the congress.

ARNOLD E. REIF

Lovelace Foundation, Albuquerque, New Mexico

Semiconductors and Phosphors

An international conference on semiconductors and phosphors was held in Garmisch-Partenkirchen near Munich, Germany, 27 Aug.–1 Sept. The conference was sponsored by the International Union of Pure and Applied Physics with the support of UNESCO. It was the third international conference on semiconductors; the first was held at Reading, England, in June 1950, and the second was held at Amsterdam, the Netherlands, in June 1954. The careful preparation of the organizational committee, consisting of W. Gerlach, G. Joos, H. Maier-Leibnitz, M. Schön, and H. Welker, contributed greatly to the success of the conference. The conference was attended by about 460 scientists from 18 different countries. About 90 papers, including summarizing reviews as well as communications of new work, were presented.

The field covered by the papers was outlined by W. Schottky (Erlangen) in a keynote address. A number of papers dealt with the introduction of crystal imperfections. The incorporation of foreign atoms, as related to the lattice defects, the carrier concentration, and the composition of the surrounding gas, was discussed in a paper by Kröger and Vink (Philips, Eindhoven). Similar problems were discussed by Riehl (Techn. Hochschule, München) in connection with luminescence in ZnS and other II-IV compounds. The energies of foreign ion incorporation in ionic crystals was considered by Brauer (Osram, Augsburg). Crystal defects produced in the growth of semiconductor crystals was discussed by Billig (Aldermaston, England), and experiments on the generation of dislocations by thermal stress were reported by Penning (Philips, Eindhoven). The effects of lattice defects produced by irradiation with high-energy particles were reported by Fan and Lark-Horovitz (Purdue University) for a number of semiconductors and by another paper dealing with the effect of alpha-particles on silicon *p-n* junctions (P. Günther and G. Köhl).

Investigations of various properties of semiconductors were reported. Drift mobility of carriers and magnetoresistance were studied for different substances. Carrier lifetime and trapping, photoconductivity, and photoelectromagnetic effect were subjects of several papers. Semiconductors besides Ge, Si, and the III-V compounds were studied. Among these are SiC, Bi_2Te_3, and new ternary compounds—that is, $HgIn_2Te_4$ and various II-IV-V_2 compounds of chalkopyrite structure, such as $CdSnP_2$.

The effect of electron-phonon interaction in thermal conduction and thermoelectricity was discussed in two papers, one of which, by Herring (BTL), gave a comprehensive treatment of the subject. Various effects of elastic strain on the conductivity of semiconductors were discussed by Keyes (Westinghouse). A paper on the magnetic susceptibility of semiconductors was given by Busch (Zürich).

Recent progress in the study of surface states in Ge and Si was reviewed by Bardeen (University of Illinois). Other papers on surface phenomena dealt with surface states in PbS, electron emission from Ge following bombardment by high-energy electrons, and so on.

In the field of phosphors, the transport of excitation energy was discussed by Kallmann (New York University) for

liquid organic systems and by Hoogenstraten (Philips, Eindhoven) for inorganic crystal phosphors. Several papers were concerned with luminescence and its quenching in ZnS and CdS phosphors containing different activators. Nonsulfide phosphors were reviewed by Henderson (Thorn Electrical Industries).

Concerning electroluminescence, the mechanism of the effect was discussed by Klassens (Philips, Eindhoven) for sulfide phosphors suspended in a binder. Destriau and Domerque (Laboratoire de Luminescence, Paris) reported experiments showing the absence of a voltage threshold. Photo emission accompanying breakdown and recombination processes in silicon were reported by McKay (BTL) and Haynes (BTL), respectively. Electroluminescence in other semiconductors was also reported.

There were theoretical papers on various problems, including statistics of trapping by Landsberg (University of Aberdeen), Zener effect and impact ionization by Franz (Universität, Münster). On the more practical side, Spenke (Siemens-Schuckert, Pretzfeld), talked about the preparation and properties of silicon power rectifiers, and several other papers dealt with *p-n* junctions in Ge and Si.

The papers will be published in a special volume to appear early in 1957.

H. Y. FAN
Purdue University, Lafayette, Indiana

Meeting Notes

■ A proposed merger will highlight the national convention of the Association of Technical Writers and Editors and the Society of Technical Writers at the Hotel Statler, New York, 15–16 Nov. The merger proposal, if adopted, would bring together 1000 members of TWE and 500 members of STW in the largest national organization of specialists in technical communications.

More than 1000 members from both groups are expected to attend. The program, on the theme "What is expected of technical writers," includes papers by 20 technical editors, librarians, illustrators, and educators. Principal sessions will cover improved technical writing performance, producing and organizing technical literature, publications problems, instructional manuals, and industrial and government technical writing.

■ A 2-day conference on undergraduate mathematics curriculum, sponsored jointly by the National Science Foundation and Hunter College, was held recently at Hunter under the direction of Mina Rees, dean of faculty. The meeting, which was attended by mathematicians from both endowed and publicly supported colleges, was called as a result of recommendations by the Subcommittee on Undergraduate Colleges of the Committee on Survey of Research Potential and Training in the Mathematical Sciences. The committee operates under a National Science Foundation grant to the University of Chicago. G. A. Hedlund, chairman of the mathematics department, Yale University, is chairman of the subcommittee. Other members are H. W. Brinkman, Swarthmore College; W. L. Duren, University of Virginia; A. G. Gleason, Harvard University; J. G. Kemeny, Dartmouth College; K. O. May, Carleton College; Leon W. Cohen, National Science Foundation.

The colleges represented were selected on the basis of their having an active program for meeting current demands for more adequate mathematical training. Participants reported on their programs and methods, which were then discussed by the conference. The results of the two days of deliberation will be issued in the form of a report that will be widely distributed, so that new ideas on undergraduate mathematical instruction can be made available to the whole community of mathematics.

■ A search for high-school students who are capable of filling this country's need for scientists and engineers was planned at a Joint Program for Technical Education, sponsored by the Columbia School of Engineering, at Arden House, Harriman, N.Y., 30 Oct.–2 Nov. The program was supported by the Hebrew Technical Foundation of New York. The conference was the first of a series planned to work out ways in which engineering schools and colleges can help science departments of high schools.

Principals and guidance counselors from a pilot group of 25 schools in the New York area have been invited to meet with representatives of engineering schools, liberal arts colleges, and professional and industrial groups to devise machinery for increasing the number of students going on to higher technical education. Talks and papers presented by manpower, teaching, and testing experts set the pattern for workshop discussions. The discussions and the speeches will be published.

The specialists who addressed the conference included Howard A. Meyerhoff, executive director of the Scientific Manpower Commission; Charles C. Cole, Jr., assistant dean of Columbia College; Paul Brandwein of Teachers College and author of *The Gifted Student as Future Scientist*; Frank H. Bowles, director of the College Entrance Examination Board; Henry Chauncey of the Educational Testing Service, Princeton, N.J.; and Sherwood R. Mercer, program chairman of the School of Engineering's first Combined Plan Conference.

■ The fall meeting of the American Society for Pharmacology and Experimental Therapeutics will be held 8–10 Nov. in French Lick, Ind., according to an announcement made by Harold C. Hodge, secretary.

Forthcoming Events

November

29–1. Florida Acad. of Sciences, 21st annual, Tampa. (R. A. Edwards, Geology Dept., Univ. of Florida, Gainesville.)

30. **American Rheumatism Assoc., Bethesda, Md. (E.F. Hartung, 580 Park Ave., New York, N.Y.)**

30–1. **Oklahoma Acad. of Science, Stillwater. (D. E. Howell, Entomology Dept., Oklahoma A. & M. College, Stillwater, Okla.)**

30–1. **Tennessee Acad. of Science, Murfreesboro. (D. Caplenor, Dept. of Biology, Peabody College, Nashville 4, Tenn.)**

December

2. American Acad. of Dental Medicine, 11th mid-annual, New York, N.Y. (A. Reiner, 114–01 201 St., St. Albans 12, N.Y.)

2–7. Radiological Soc. of North America, Inc., annual, Chicago, Ill. (D. S. Childs, 713 E. Genesee St., Syracuse 2, N.Y.)

3–8. International Cong. on Rockets and Guided Missiles for Continental and Telecommunications Connections, Paris, France. (Assoc. for the Encouragement of Aeronautical Research, rue de Courtly 1, Paris 7e.)

5. Recent Advances in the Chemistry of Natural Products, 8th annual Ciba Foundation Lecture, London, England. (G. E. W. Wolstenholme, 41 Portland Place, London, W.1.)

5–7. Instrumentation Conf., 2nd, Inst. of Radio Engineers, Atlanta, Ga. (M. D. Prince, Engineering Experiment Station, Georgia Inst. of Technology, Atlanta.)

6. **Amino Acid Imbalance in Nutrition, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)**

6–7. American Astronautical Soc., 3rd annual, New York, N.Y. (N. V. Petersen, AAS, 516 Fifth Ave., New York 36.)

6–8. **American Phytopathological Soc., annual, Cincinnati, Ohio. (G. S. Pound, Dept. of Plant Pathology, Univ. of Wisconsin, Madison.)**

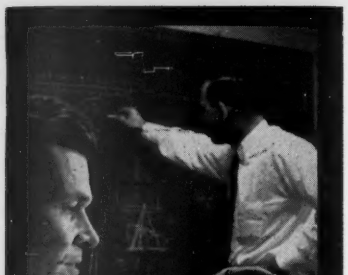
6–8. Potato Assoc. of America, annual, Cincinnati, Ohio. (W. J. Hooker, Dept. of Botany and Plant Pathology, Michigan State Univ., East Lansing.)

6–9. **American Psychoanalytic Assoc., New York, N.Y. (J. N. McVeigh, APA, 36 W. 44 St., New York 36.)**

7–8. **Association for Research in Nervous and Mental Disease, annual, New York, N.Y. (R. J. Masselink, 710 W. 168 St., New York 32.)**

8–11. **American Acad. of Optometry, annual, Houston, Tex. (C. C. Koch, 1506 Foshay Tower, Minneapolis 2, Minn.)**

9–12. **American Inst. of Chemical En-**



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gineers, annual, Boston, Mass. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36.)

9–12. American Soc. of Agricultural Engineers, Chicago, Ill. (J. L. Butt, ASAE, St. Joseph, Mich.)

10–12. American Nuclear Soc., winter meeting, Washington, D.C. (ANS, P.O. Box 963, Oak Ridge, Tenn.)

10–12. Eastern Joint Computer Conf., New York, N.Y. (J. R. Weiner, Remington Rand, Inc., 315 Fourth Ave., New York, N.Y.)

10–12. North Central Weed Control Conf., 13th annual, Chicago, Ill. (O. C. Lee, Agricultural Extension Service, Purdue Univ., Lafayette, Ind.)

12–14. European Assoc. of Exploration Geophysicists, Milan, Italy. (B. Baars, Carel Van Bylandtlaan 30, The Hague, Holland.)

13–15. Texas Acad. of Science, annual, Brownwood, Tex. (G. C. Parker, Texas A.&M. College, College Station.)

19. Arctic Branch, Alaska Div., AAAS, College Alaska. (Miss C. Juedes, Box 47, College.)

26–31. American Assoc. for the Advancement of Science, annual, New York, N.Y. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5.)

The following 55 meetings are being held in conjunction with the AAAS annual meeting.

AAAS Academy Conference (L. Taylor, West Virginia Univ., Morgantown). 29–30 Dec.

AAAS Cooperative Committee on the Teaching of Science and Mathematics (M. Meister, Bronx High School of Science, New York 68). 27 Dec.

AAAS-Gordon Research Conferences (W. G. Parks, Univ. of Rhode Island, Kingston). 27 Dec.

Alpha Chi Sigma (H. G. Seavey, 30 Church St., Room 340, New York 7). 28 Dec.

Alpha Epsilon Delta (M. L. Moore, 7 Brookside Circle, Bronxville, N.Y.). 29 Dec.

American Assoc. of Clinical Chemists (A. E. Sobel, Jewish Hospital of Brooklyn, Brooklyn 16, N.Y.).

American Assoc. of Hospital Consultants (E. D. Barnett, School of Public Health, Columbia Univ., New York 32.)

American Assoc. of Scientific Workers (R. J. Rutman, 6331 Ross St., Philadelphia 44, Pa.). 29 Dec.

American Astronomical Soc. (J. A. Hynek, Harvard College Observatory, Cambridge 38, Mass.). 26–29 Dec.

American Documentation Inst. (J. Hilsenrath, National Bureau of Standards, Washington 25). 27–29 Dec.

American Educational Research Assoc. (A. G. Wesman, Psychological Corp., 522 Fifth Ave., New York 36). 29 Dec.

American Meteorological Soc. (R. J. Roth, Crop-Hail Insurance Actuarial Assoc., 209 W. Jackson Blvd., Chicago, Ill.). 28 Dec.

American Museum of Natural History (G. Reekie, AMNH, Central Park West at 79 St., New York, N.Y.). 26 Dec.

American Nature Study Soc. (R. L. Weaver, Univ. of Michigan, Ann Arbor). 26–30 Dec.

American Philosophical Assoc., Eastern Div. (J. Wild, Harvard Univ., Cambridge 38, Mass.). 27 Dec.

American Psychiatric Assoc. (B. Pasamanick, Ohio State Univ., Columbus 10). 28–29 Dec.

American Soc. of Hospital Pharmacists (G. E. Archambault, U.S. Public Health Service, Washington 25). 29 Dec.

American Soc. of Range Management (F. G. Renner, Soil Conservation Service, U.S. Dept. of Agriculture, Washington 25). 28 Dec.

American Statistical Assoc. (R. E. Johnson, Western Electric Co., New York 7).

Association for Computing Machinery (J. P. Nash, Univ. of Illinois, Urbana).

Association of American Geographers (P. M. Stern, Conservation Foundation, 30 E. 40 St., New York, N.Y.).

Astronomical League (H. B. Davidson, 812 Park Ave., New York 21.)

Conference on Scientific Editorial Problems (J. G. Adashko, Ford Instrument Co., Long Island City, N.Y.). 26–28 Dec.

Conference on Scientific Manpower (T. J. Mills, National Science Foundation, Washington 25). 26 Dec.

Ecological Soc. of America (M. F. Buell, Rutgers Univ., New Brunswick, N.J.). 26–30 Dec.

Entomological Soc. of America (P. W. Oman, Plant Industry Sta., Beltsville, Md.). 27–30 Dec.

Genetics Soc. of America (A. W. Pollister, Columbia Univ., New York 27). 28 Dec.

History of Science Soc. (Miss P. Kibre, Hunter College, New York, N.Y.). 27–29 Dec.

Institute of Mathematical Statistics (Miss E. Scott, Univ. of California, Berkeley 4).

International Council for Exceptional Children (M. H. Fouracre, Columbia Univ., New York 27). 26 Dec.

International Union for the Study of Social Insects, North American Section (T. C. Schneirla, American Museum of Natural History, Central Park West at 79 St., New York, N.Y.). 26–27 Dec.

Mountain Lake Biological Sta. (B. D. Reynolds, Univ. of Virginia, Charlottesville).

Mycological Soc. of America (L. S. Olive, Columbia Univ., New York 27). 26 Dec.

National Acad. of Economics and Political Science (D. P. Ray, George Washington Univ., Washington, D.C.). 27 Dec.

National Assoc. for Gifted Children (Miss A. F. Isaacs, 409 Clinton Springs Ave., Cincinnati, Ohio).

National Assoc. for Research in Science Teaching (N. Washton, Queens College, Flushing 67, L.I., N.Y.). 27 Dec.

National Assoc. of Biology Teachers (J. Breukelman, State Teachers College, Emporia, Kan.). 26–30 Dec.

National Assoc. of Science Writers (J. E. Pfeiffer, New Hope, Pa.).

National Geographic Soc. (W. R. Gray, NGS, 16 and M Sts., NW, Washington 6). 29 Dec.

National Speleological Soc. (Brother G. Nicholas, LaSalle High School, Cumberland, Md.). 29 Dec.

New York Acad. of Sciences (R. F. Nigrelli, New York Zoological Soc. and

M. Kopac, New York Univ., Washington Sq., New York, N.Y.). 29 Dec.

Philosophy of Science Assoc. (C. W. Churchman, Case Inst. of Technology, Cleveland, Ohio). 29–30 Dec.

Pi Gamma Mu (B. H. Williams, Industrial College of the Armed Forces, Washington 25). 26 Dec.

Scientific Research Soc. of America (D. B. Prentice, Yale Univ., New Haven, Conn.). 26–27 Dec.

Sigma Delta Epsilon (C. Chandler, Boyce Thompson Inst. for Plant Research, 1086 N. Broadway, Yonkers 3, N.Y.).

Sigma Pi Sigma (M. W. White, Pennsylvania State Univ., University Park).

Society for the Advancement of Criminology (D. E. J. MacNamara, New York Inst. of Criminology, 2109 Broadway, New York, N.Y.). 29 Dec.

Society for the Advancement of General Systems Theory (L. von Bertalanffy, Mt. Sinai Hospital, Los Angeles 48, Calif.). 29–30 Dec.

Society for the Study of Evolution (H. Lewis, Univ. of California, Los Angeles 24). 27–29 Dec.

Society of General Physiologists (A. Shanes, National Institutes of Health, Bethesda, Md.).

Society of Systematic Zoology (R. E. Blackwelder, Box 500, Victor, N.Y.). 27–30 Dec.

Society of the Sigma Xi (T. T. Holme, Yale Univ., New Haven, Conn.). 27 Dec.

Society of Vertebrate Paleontology, annual (J. T. Gregory, Peabody Museum of Natural History, Yale Univ., New Haven, Conn.). 28–30 Dec.

Torrey Botanical Club (David Keck, New York Botanical Garden, Bronx Park, New York 58). 26–27 Dec.

United Chapters of Phi Beta Kappa (C. Billman, PBK, 1811 Q St., NW, Washington 6). 27 Dec.

27–28. Fluid Mechanics in Chemical Engineering, American Chemical Soc., Lafayette, Ind. (W. E. Ranz, Dept. of Engineering Research, Pennsylvania State Univ., University Park.)

27–28. Linguistic Soc. of America, Philadelphia, Pa. (A. A. Hill, Box 7790, University Sta., Austin 12, Tex.)

27–29. American Mathematical Soc., 63rd annual, Rochester, N.Y. (J. H. Curtiss, AMS, 80 Waterman St., Providence 6, R.I.)

27–29. American Physical Soc., Monterey, Calif. (W. A. Nierenberg, Univ. of California, Berkeley 4.)

27–29. Western Soc. of Naturalists, annual, Goleta, Calif. (D. Davenport, Santa Barbara College, Goleta.)

27–30. American Economic Assoc., annual, Cleveland, Ohio. (J. W. Bell, 629 Noyes St., Evanston, Ill.)

27–30. American Finance Assoc., annual, Cleveland, Ohio. (G. E. Hassett, Jr., New York Univ., 90 Trinity Place, New York 6.)

28. Society for the Advancement of Criminology, annual western, Fresno, Calif. (W. Dienstein, Fresno State College, Fresno.)

28–29. American Folk-Lore Soc., annual, Santa Monica, Calif. (MacE. Leach, Bennett Hall, Univ. of Pennsylvania, Philadelphia 4.)

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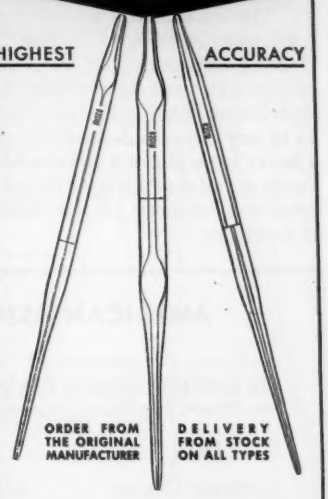

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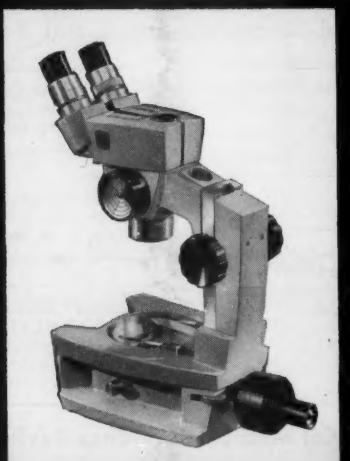

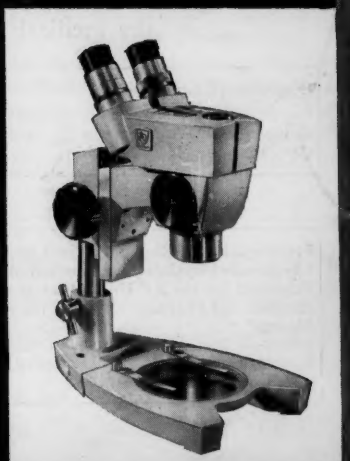

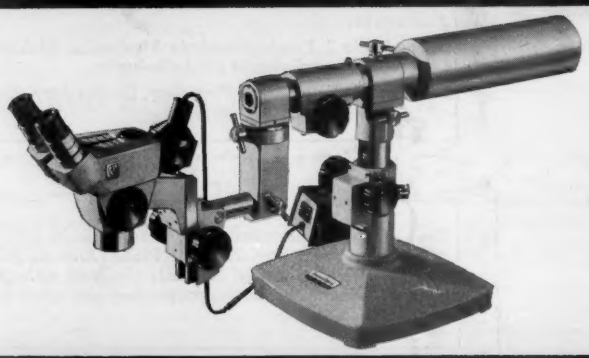

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